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BRIGHTON.

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AN

ELEMENTARY DICTIONARY,

OR,

Cyclopædia,

FOR THE USE OF

MALTSTERS, BREWERS, DISTILLERS,

RECTIFIERS,

VINEGAR MANUFACTURERS,

AND OTHERS.

BY GEORGE ADOLPHUS WIGNEY,

Brewer,

BRIGHTON, SUSSEX.

"There is no royal road to knowledge."

BRIGHTON:
PRINTED FOR THE AUTHOR, BY R. SICKELMORE, AT 45, HIGH STREET, (LATE THE CATHOLIC CHAPEL)
AND SOLD BY
P. RICHARDSON, BOOKSELLER, 23, CORNHILL, LONDON; J. LONG, INSTRUMENT MAKER, 20, LITTLE TOWER STREET, LONDON; MESSRS. BANCKS AND CO., BOOKSELLERS, MANCHESTER; MESSRS. WHYTE AND CO., BOOKSELLERS, EDINBURGH; MESSRS. CURRY AND CO., BOOKSELLERS, DUBLIN; AND MAY BE HAD OF ALL OTHER BOOKSELLERS.
1838.

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PREFACE.

The love of ease is a predominant passion of the human mind, and the paradoxical condition of man is, that without labour he cannot obtain rest. The organized structure of the body and mind is such, that the laborious and active employment of both, is requisite to induce the desire for, and the obtainment of rest; and the obtainment of the latter furnishes the motive and capability for the performance of the former. And hence the alternations of labour and rest, furnish that zest to existence, without which life would be insupportable.

But the love of ease is a legitimate and salutary passion, inasmuch as it is a powerful incentive to mental and bodily action, inducing the acquirement of knowledge and personal exertion to endeavour to obtain it, leading to general improvement, and the acquisition of social comforts.

The strong desire of youth is to toil severely for the ease of later years. Reason and observation teach him that the day may come, when sickness, infirmities and age may paralize his arm, and unnerve his mind, and that in such a day the fruits of labour may be needed and enjoyed.

But he that builds must at the base commence!—he must lay a foundation firm and strong upon a stable soil—he must temper his mortar well, and lay each brick and stone with care, precision, and by plummet, line and rule—he must often pause between to cause the perfect cementation of the whole—he must brace, bind and tie as he progresses—he must toil with patience, perseverance and with hope, until he lays the top-stone, and having laboured well and long, then may he crown the whole with joy, and rear the floating emblem expressive of his pleasure.

And thus it should be in every branch of human learning; the rudiments the base—the firm and solid mind the scite—diligence the well tempered mortar—facts and truths the brick and stone; and to observe, to comprehend and act with order, system and decision; to fix the whole indelibly upon the mind; to read, reflect and well deduce from every page; to meet difficulties with an indomitable will to overcome, abstruse subjects with indefatigable research, and disappointment with an expectation that never shall succumb, is to ensure the ultimate obtainment of knowledge of the highest order which is attainable by man.

But it is the love of ease which too often prompts a shorter course—a flight to the pinnacle, and a fall for proud presumption; instead of the safe, yet weary spiral way to eminence and elevation.

And where is the manufacturer who has not essayed the shorter course—the airy flight for ample knowledge of his business; and after many fruitless flutterings and loss of feathers, has been compelled to seek first principles, as the only safe and certain way to reach the elevated prize; and to tread with slow and weary step the steep ascent, after the noontide strength of youth is gone.

Such has been my case, and I believe the lot of thousands. And as instruction is the purport of my writing, and the few following incidents in my first career in the brewing business, may be to some both amusing and instructive, and will serve to illustrate the maxim which I have endeavoured to inculcate, that the love of ease induces labour to obtain it, and that labour induces the desire for and the obtainment of rest; and as they will serve to exemplify some of the effects resulting from an endeavour to accomplish manufacturing processes, without the possession of the prerequisite elementary knowledge thereof, and prove that "necessity is the mother of invention," I will therefore venture to relate them.

A four-quarter brewery ready fitted up being offered, and a motive existing for the acceptance, I commenced the business of a brewer above twenty years since, without the slightest theoretical or practical knowledge of the subject or its details. I engaged a person to instruct me, who received his premium and withheld information, and at the end of about a fortnight he left, and I learnt just what I could see enacted in three or four brewings, without receiving any communications as to the why or wherefore. The produce of the first brewing which I performed myself, cost me three halfpence per gallon less than the cost of such as my instructor brewed, and I thought myself a clever fellow. The brewery was very small and comprised no cellarage. It consisted of two cleansing rooms, the fermenting tuns forming the line of separation, and were upon a level with, and adjoining to the street, which with a small back yard, constituted the extent of premises on the ground floor. The under back and basement of the copper occupied a space in one of the cleansing rooms. The second floor consisted of three small cooling backs, mash tun stage, mash tun, copper and stoke hole. The dimensions of the whole of the premises to the best of my remembrance, were about 24ft by 30ft, including the yard. The whole of the work was performed by hand labour. A brewing in winter occupied from 12 to 14 hours, and in summer, from 24 to 28 hours, before the worts were all down into the fermenting tuns. The cleansing rooms, fermenting tuns and cleansing casks, were so exposed to the external atmosphere, that in winter the table beer often froze in the cleansing casks after fermentation, and in the summer the cleansing casks, although full, often leaked from excessive heat. In the winter the wort in the tun, although pitched very high, would often be reduced below a fermenting temperature; and in summer, although pitched as low as the night air would reduce its temperature, often attained most rapidly to a heat of 90 degrees.

In about one year, having completely set the goods of two brewings, and being compelled to give the whole produce to the hogs, consisting of eight quarters of malt and plenty of ropy wort; and having crammed the premises with stale beer, I became convinced that I was any thing but a clever fellow.

Well! what was to be done? the work of reformation. The unlearning of the little which I had learnt, and the learning of that which I had never learnt, recommencing at the beginning instead of the end. And who was to teach me? stern necessity. Well! nothing daunted, I began.

The fermenting tuns were furnished with an accelerator for the winter, the same utensil serving (not so effectually,) for a refrigerator in the summer. The stale beer was sold at a very great sacrifice. A vault was dug in the yard about 9ft. deep, and arched over for a cleansing room. A discovery made of a formula for the correct calculation of mashing heats under every circumstance: and commenced brewing at about noon in the summer, instead of four o'clock in the morning, and worked all night to save time, and to prevent so long an exposure of worts to a sultry and oxygenated atmosphere.

Well! and what were the disasters of the second year? Cleansed a guile of strong beer late in the evening in the new cleansing room; went early in the morning to fill it up; got half way down the steps, was seized with giddiness and stupor, and rushed back again with a narrow escape of life; stillions all working over, but could not get down to draw them off and fill up the casks. Consulted the knowing ones, one of whom advised me to throw plenty of water down; did so, but to no good purpose. Another advised me to get some fresh dried lime and throw down; I did so, and soon cleared the room of the carbonic acid gas. Asked him where he got his information; he told me from some chemical work; took good care to read it, and learnt much that was useful beside. The new cleansing room was abandoned, because it was impossible to ventilate it from the bottom, situated as it was. Malted some tick beans for curiosity; they absorbed so much water in the cistern, as to cause the charge of nearly or quite double duty. Mixed therewith some barley malt and brewed one guile, obtained but little extract, that was nauseous and spoiled the whole. Burnt down a malthouse by snapping porter malt on an improper kiln; killed a horse by feeding him on the half burnt barley and bean malt; by leaving on the cover of the manhole to wooden wort back over copper, while running off boiling wort into hop back, created a vacuum in the copper, and the pressure of the atmosphere broke the bottom of the back asunder, and forced it into the copper with a tremendous explosion. Well! and who can say that a little knowledge is not useful, although Pope says it is a dangerous thing?

It is said that "bought experience is the best, if not too dearly bought;" and if the reader is not already convinced that for want of a little elementary knowledge of the business which I precipitately engaged in, I could furnish him with many other incidental disasters, which would not fail to produce such an effect.

But "all is well that ends well," is another adage not inapplicable to my case; for had I not severely smarted for want of elementary knowledge, I most probably should never have sought it; and as an illustration of the utility of seeking and obtaining it, my last labours in a four-quarter brewery, built and fitted up on a plan of my own designing, for the term of about three years, were unattended with any prejudicial occurrences; and I had the pleasure of completing each four-quarter brewing, in from seven to eight hours by manual labour, from the time of first mashing until the whole of the worts were in the tuns, consisting of ale and table worts, with much less labour, cost of fuel, or waste of wort, than in the first brewery.

Those who are conscious of their own need of knowledge, are generally able to appreciate the probable wants of others; and influenced by a desire to impart such as I have been able to meet with, as a theoretical, experimental and practical gleaner, during a period of more than twenty years, I trust that the endeavour, however imperfectly fulfilled, will prove both useful and satisfactory to many, who may need the information which the following work contains.

The primary object which I have had in view in penning this volume, has been to render the parties to whom it is addressed, better acquainted with the elementary principles of their respective manufacturing processes, preparatory to their endeavours to improve their practical systems. To enable them first to perceive the need of improvement, secondly to perceive the way to effect it, and thirdly to discriminate between the spurious and genuine information which may occasionally be offered to them, and to form a correct estimate of its intrinsic value, and thereby to avoid the rejection of that which is truly useful, and a superfluous expenditure for that which is either valueless or prejudicial.

In carrying this object into effect, the reader may have much occasion to complain of tautology oft repeated, by furnishing the same information frequently under several different heads; but the necessity of the endeavour to render every article or subject as complete and independent of each other as possible, irrespective of their close and intimate connection and assimilation, must be my apology for thus offending. And having written each without reference to any one preceding, I trust that the same truths, facts and opinions, agreeing in identity, yet clothed in variable expression, will lose none of their force or interest by frequent repetition.

The man of science and the critic, will, I expect, accuse me of advancing and endeavouring to inculcate some new and insufficiently supported doctrines, and delivering them with a dictum, as if they were established, unimpugnable and universally recognized; and to the charge I plead guilty, craving mercy, referring them and every other reader to the article "Hypothesis," and pleading convenience in extenuation of the misdemeanour.

The present work was prompted by an enquiry of one of the purchasers of my Practical Treatise on Malting and Brewing, as to what chemical works he could read with the most advantage, so as to obtain a more scientific knowledge of his business; to which in reply, I referred him to several. But reflecting subsequently upon the task assigned him, of wading through a great many portly volumes for that information which he needed, and which he would find in fragments diffused over an immense number of pages, and much which he might require he would never find therein; I determined on the endeavour to furnish in a concentrated form, and in one small volume, such information as I had collected, and which I conceived might prove serviceable to himself and others, and which I trust will meet with both indulgence and a favorable acceptatance by those for whom it is designed.

ELEMENTARY DICTIONARY.

ABSORB, *to suck up, to hold in combination, &c.*

The term absorb, is one of great consideration in various manufactories, and the amount of absorption frequently becomes a subject of calculation in the account of profit and loss.

In the malthouse the maxim of the excise is to charge the malt duty, on the largest quantity of grain they can find in process of malting, from the time of steeping until it is thrown on the kiln to dry; making a definite and arbitrary allowance in deduction, for the increase of the bulk of the grain in the several stages of the process, agreable to an established rule, regardless of all circumstances, that may cause such an allowance, to be more or less adequate to the quantity of dry grain which may have been steeped, or the dry malt which may be thrown from the kiln; and such deductions are regulated in amount, by the several situations in which the grain is found, whether in the cistern, under water, or subsequent to the withdrawal of the water from it; and whether in the couch or on the floor; and in proportion to the time which may have elapsed, subsequent to its removal from the couch.

As the amount of duty charged, is then proportionate to the amount of increase in the bulk of the grain, by the absorption and retention of the steep water; and as the different species of grain, and even the same species, are subject to an unequal absorption, and consequently to an unequal increase in bulk; so is the charge of duty unequal, as relates to the quantity of dry grain steeped, or the quantity of malt thrown off the kiln; and consequently, the average amount of duty to which the several species of grain are liable, should be taken into the account of calculation on the debtor side, and the average product of each, on the credit side; so as to enable the malting salesman, or the malting brewer, to conclude, which species of grain according to the market price, will answer his purpose best to malt.

As some years, one species of malting grain is higher or lower in price, or better or worse in quality than another species, in the relative proportion of usual prices and quality; every malting brewer more particularly, should be in possession of the average amount of duty, to which each species is liable; and the average amount of the product of each, and the proper mode of brewing each, in order that he may be enabled, advantageously to change from one species to another, as circumstances induce.

The absorption of water by grain, is neither instantaneous or rapid; but on the contrary is very slow and tedious; and as the cuticle or skin of grain, is coated with an oleaginous or resinous substance, such material must first be dissolved by the water, before the water can penetrate into the body of the grain; and when such solution is effected, the water gradually penetrates into the interior; and combines in chemical admixture with the component substance of the grain.

The quantity of water absorbed during the process of steeping, is by no means an unimportant consideration, as the successful conduction of the process of germination, very materially depends on the absorption of a proper quantity of water; and it is much to be regretted, that the legislative period, too often interferes with the maltster's judgment; and that the maltster has no better rule than his own opinion, founded on his own experience, or fancy, to direct his judgment, in allotting the time he deems necessary; and regardless of the temperature of the steep water, or the atmosphere, and the quality and condition of the grain as well as the species, it is too customary for him to choose, a determinate and fixed period at the commencement of the season, and adhere to it under all circumstances throughout its continuance. This fallacious and erroneous method of determining the time of steeping, and the invariable adherence to it, throughout the whole of a malting season, is one among many of the evils in the system of malting, that needs reformation.

The brewer is also interested in the amount of absorption of malt in the mash tun, as the quantity of menstruum retained, after the whole of the first wort is withdrawn, that will run from the goods, is one of the indications of the quality of the malt, or the correctness, or approximation thereto, of the first mashing heat.

The absorption and retention of wort by hops, is also another point of consideration by the brewer; whose annual profits, may be seriously affected by the retention, if he does not reclaim as much of it as possible.

The annual absorption of spirits by wood, and the consequent loss, is both to the distiller and rectifier, a subject of serious consideration; and one in which those of minor traffick are also interested.

ABSTRACT, *to take from, to separate, to withdraw, &c.*

In the several manufactories of the various products of grain in a liquid form; the first operation consists in the impartation of water to the grain in the steeping cistern, as a prelude to the process of germination, to render such grain capable of effecting the required production: or the impartation in the mash tun, to cause an immediate produce from the grain in an unmalted state, having first prepared it for solution, by crushing or grinding.

The conversion of grain from its natural state to that of malt, is to the brewer and vinegar maker, an indispensable preliminary measure, to the production of such a wort, as will by the process of a vinous fermentation, furnish him with a compound of satisfactory quality. And if the vinegar maker, whose ultimate object is an acetous fermentation, finds it absolutely necessary that he should use no raw grain with his malt, but malt alone, to produce a wort liable to pass through a vinous fermentation only, and not a vino-acetous fermentation; of how much greater necessity then, is the sole use of malt by the brewer, whose purpose is strictly to avoid all the liabilities of a vino-acetous, or an ultimate acetous fermentation.

But the distiller, is content to use a very small proportion of malt, to the quantity of grain in its natural state; because his purpose is, to produce a spirit at the smallest possible cost; and the duty on malt, would be a barrier to the accomplishment of such a purpose: and because the rapidity of his vinous fermentation, and the prompt separation of the spirit generated from the wash, enables him to avoid the consequences of an acetous fermentation, to which he would be subject, if compelled to keep his wort for a comparatively short period of time. But with all the advantages resulting from such celerity of operation, it is with him, a case of difficulty, to prevent the occurrence of a vino-acetous fermentation.

The process of a preliminary preparation of the grain for that of extraction, and the subsequent extraction; or the immediate extraction, without preparation, may conveniently be divided into two sections, impartation or accretion, and abstraction.

To convert grain into malt, is either to impart principles which it does not possess, or more of those which it does possess, and which is necessary to alter its properties and make it a new compound; and to abstract those principles, which as grain in its natural state it does possess, and which as malt it should not possess: or if as malt it should possess, yet should not possess it in the latter state, to the same extent as in the former.

The impartation of water to grain in the cistern, effects a solution of the oleaginous or resinous matter, with which the skin is coated, softens and distends it, and renders it pervious, for the admission and abstraction of such principles, as are necessary to create the new compound, and to remove the impediments to its formation: and a portion of such water as produces this chemical effect, also causes germination to commence, by its chemical combination with the component materials of the body of the grain, a decomposition of each, resulting from the affinity and attraction of atoms, terminating in their union, and the creation of new compounds; and causing the conversion of latent heat, appertaining to each substance, into active heat; in order to effect its transference as a resident constituent of the new solid compounds, and a fugitive and volatile transformer of solid substances, into gaseous and evolating products.

The purport of malting, is to increase the quantity of gum and saccharum, and to diminish the quantity of gluten and fecula; and as grain in its natural state, is composed of these substances in variable proportions, it is quite evident, that impartation and abstraction, are the means by which the increase of the one, and the diminution of the other is effected; and the difference in the weight of malted and unmalted grain, denotes that the abstraction is more than equal to the impartation.

An abstraction of the residue of the water from the grain, which has not been decomposed in the process of germination, must be effected on the kiln, to ensure its preservation, and an impartation of the required colour and flavor.

The process of abstraction of the soluble materials of malted or unmalted grain, consists first in the impartation of a suitable menstruum at a proper temperature, and a subsequent abstraction of such menstruum, charged with such materials in solution: and as water or return wort is the usual menstruum, the former should be as mechanically and chemically pure as is possible; and the latter of correct composition, and perfectly free from acidity and putridity.

The soluble substances of which malt is compounded are four, and if each were submitted to the process of solution in a separate state, it would be found, that the most suitable temperature of solution for each would materially differ; but as they are blended together in malt, it is the brewer's business to choose such a medium temperature for his menstruum, as is best calculated to produce him, as much soluble extract as is possible, in a wort of suitable quality: and experience proves, that there is a medium, yet variable temperature of the menstruum, which is best adapted to effect such a purpose, and that there is a method (although known to but few) to discover on each occasion of brewing, what that temperature should be; and that any deviation from such a temperature, is attended with loss in proportion to its extent, above or below the right amount.

The danger attendant on a deviation from a right temperature, of the mashing menstruum, is the solution of too much of one portion of the compound, and not enough of another; or too little of each altogether, or the nonobtainment of any by a deviation to too great an extent from a proper heat; occasioning what is technically termed "setting the goods."

The extract from malt called wort, is not alone sufficient for the formation of a vinous fluid, that is calculated to please the taste of the consumer, on early or late consumption; but it requires the admixture of a corrective and grateful bitter extract, with the cloying and mawkish flavor of the malt extract, to satisfy the palate; and a large fund of carbon to unite with the oxygen, which is continually absorbed by the unfermented and fermented product, from its egress from the mash tun, until the period of its consumption. And the most suitable substances that have yet been discovered to furnish the required properties, are, the hop flower and seed: and an abstraction of their soluble properties, and the best method of its impartation to the wort, is by boiling them therein for a suitable period of time.

Boiling is not only practised for the sake of abstracting the soluble materials of the hop, but also for the purpose of abstracting a portion of the gluten contained in the wort, by its coagulation, which boiling effects.

In the boiling of wort, an abstraction of gluten by coagulation, may occur to a salutary or an injurious extent: for as the presence of gluten is necessary to a vinous or an acetous fermentation, and the presence of too much, causes a vino-acetous fermentation; the judgment of the brewer is required, to determine the extent of its abstraction by coagulation, so as to leave a sufficiency in the wort, to cause a proper vinous, and not so much, as to cause a vino-acetous fermentation.

In fermentation an additional abstraction of gluten occurs, and also a large quantity of carbonic acid gas.

An abstraction of the heat from wort after boiling, either by the air in contact with, and passing over it, while spread thin in cooling backs; or by water through the medium of a refrigerator, is treated fully under the head "Refrigerator."

The abstraction of the soluble materials from the malt, and its transference to the menstruum, is the result of an affinity and attraction, subsisting between the atoms of the soluble materials and the menstruum.

ACCELERATE, *to hasten or quicken.*

Applied to the process of malting, the remedy of acceleration is too often needed, to obviate the evils resulting from a bad system, founded on ignorance, indolence, parsimony, or carelessness.

Malthouses are generally built agreeable to mechanical conveniences, or local necessities, rather than with a reference to chemical consequences. In fact, the latter consideration is seldom thought of or entertained, either by the proprietor, architect, or builder, because neither one or the other posses any, or a sufficient knowledge of the subject: and if the latter two did, it is not their business to devise and execute a plan, agreeable to chemical requirements.

As a general rule, the proprietor does not know the chemical requirements, because necessity, or other circumstances, have not compelled him to seek and obtain, a theoretical or practical knowledge of the subject: and as an exception to such rule, if he does know, the erection of a building on the best principles is but of little use, because he is compelled to leave the mental and manual direction and performance of the process, to an uneducated, and uninformed labourer, so far as relates to a scientific knowledge of the subject. And on the supposition, that a maltster well skilled in the theoretical and practical knowledge of the process of malting, does not perform the operation himself, he must either find the working man who understands both as well as himself, (if it is possible to find such an one) or he must teach one: or else, in despite of his knowledge, he has no alternative, but to select the best blind practitioner of a tolerable system, which he may have been fortunate enough, by chance, to pick up; and in effecting such a selection, he will find his own knowledge highly serviceable, as it will enable him to appreciate the value of the workman's system, and to direct a judicious choice.

But if the master is too idle, or indifferent to the obtainment or impartation of suitable knowledge, how can we condemn, or wonder, that the unlettered labourer, should not seek, or is unable to obtain it? the more so, when he knows the master too often passes an unintelligent eye over the scene of his labours, and is alike unconscious or indifferent to the various errors and negligences of his several performances. If both master and man knew but this one simple fact, that there is a medium temperature at which the grain and the steeping water should be mixed together; surely they would not leave a leaf unturned, until they had acquired so important a branch of knowledge. Yet such is the fact, and how few are conscious of it; or if conscious, yet are they totally regardless of it, notwithstanding that the task of acquirement, and the fulfilment of the conditions, are of easy accomplishment.

Again, if they knew of another fact not less important, that the temperature of their room should be, as near as possible, at an equable and medium amount, throughout the malting season; and that the grain in the couch, and on the floors, should be kept at the same; surely some architectural endeavours would be resorted to, to ensure such an object naturally, as far as it could be accomplished; and that measures of expediency would be adopted in the process of malting, to compensate for the deficiency. But seldom is the need known, or if known, seldom is it attended to. The malthouse is built agreeable to custom, whim, caprice, local circumstances, or real or imaginary necessity. The supply of water to the cistern, may be from the well at about 50 degrees of heat, or from a reservoir at 32 degrees; and the difference in the heat is either not thought of, or if so, it is deemed a matter of little or no consequence, or an irremediable evil.

The grain is steeped, regardless of its temperature, or that of the steep water, for such a period as is restricted by the excise law; or short of the limited period to an extent, as is induced by the habits or practice of the maltster, without any reference to the judgment, unless at the commencement of the season; when some few will then determine, what shall be their invariable steeping period for the whole of the season, deducing their opinion of what that period should be, from a report of the general quality of the malting grain, and the general condition in which it was harvested.

By this random practice, grain may be steeped with water too warm or cold, and for too short or long a period; and on the supposition that grain has been steeped with water too cold, and for too long or short a period, the consequence is, that although it is thrown thick into the couch, as the law will not allow it to remain there long, it must be thrown out before germination has commenced, or the temperature of the grain is raised, by a decomposition of a portion of the imbibed steep water, and the component substances of the grain, to that point, below which germination cannot commence: then necessarily follows the process of acceleration, which is effected by throwing the grain from the couch into a thick heap, and occasionally to cover it up with sacks or cloths, until it begins to nip; and the result of having recourse to such a remedy, rather than to avoid the evil in the first instance is, that while the upper surface of the grain is raised but to the germinating temperature, the lower surface is raised much above it, and each strata between is proportionably affected; and to effect this operation of acceleration, a considerable portion of the steep water, which was absorbed purposely, to carry on the process of germination to the extent needed, is lost by its decomposition, to generate that heat, which should have been imparted to the steep water, previous to the steeping of the grain. Thus it may be said, that an unnecessary cause, occasions the need of acceleration, as a remedy for an avoidable evil: and well would it be if the mischief terminated here, but it does not; for the first false step, leads to a succession of evils, that pervade and continue throughout the whole process, and is evidenced by an inequality in the growth of the grain; by the necessity of incurring the risk, resulting from an infraction of the excise laws, by sprinkling on the floors before the permitted time; or experiencing the effect of a languid, improper, and immature process of germination; while every remedial measure which is adopted, to accelerate the growth from the couch to the kiln, is, (irrespective of the resulting loss and risk) attended with more labour, care, and anxiety, than would arise from the adoption in the first instance, of the measures of prevention.

The brewer, distiller, and vinegar maker, &c. may profit much by acceleration in the process of extraction, refrigeration, and fermentation; but it is a race to run, that needs the light of a well informed judgment, long experience, careful observation, and punctilious attention to all the minutiæ of an every varying practice, to run it well.

As the result of long experience and practice, I can, and do assert, that by an improved system of construction and fitting up of a brewery, occupying much less room, and of much less cost, than by the old and accustomed mode of building and fitting up; and by an improved system of brewing therein, that from four to thirty quarters of malt, may be brewed in single brewings, in the space of time, of from six to eight hours from the time of first mashing, until the whole of the worts are in the tun; and double brewings, in the space of from ten and a half, to fourteen hours and a half; and that by the same improved system of brewing, single brewings of the same extent, may be begun and finished, in premises of usual construction and fitting up, with the addition of one of my refrigerators, in the space of from eight to eleven hours; and double brewings, in from fourteen to twenty hours, and the produce fit for consumption in a state of perfect transparency, and of good quality, on the sixth day from the day of brewing.

The process of acceleration is too often resorted to, in many breweries, as well as malthouses, as a necessary remedy for an avoidable evil, instead of a preventative to the need of an avoidable remedy.

The situation of the fermenting tuns, is generally the result of a choice, dictated by considerations of mechanical advantage, architectural expediency, incapacity to contrive, or some other cause; while not one thought is bestowed on the average atmospheric temperature of the situation chosen, nor the extent or the frequency of the variations during the year; therefore the hapless brewer has to conduct his fermentations in such tuns, subject to all the vicissitudes of temperature which may occur; and in case he is not a thorough judge of his business, and knows not how to adapt his system to the exigences of every case, he will often find it necessary to accelerate or retard the process, and will be subject to all the concomitant evils, resulting from the administration of remedies, instead of avoiding them by the adoption of measures of prevention.

"Prevention is better than cure," is an adage that should be conspicuously posted up, in each department of every manufactory: and the projector of a building for a manufactory and its fittings up, should be one, who thoroughly comprehends both the mechanical and chemical details, of every minute process of the manufacture for which it is intended; and his first care should be, to make suitable arrangements for every chemical exigency, in preference to the mechanical; and next to provide such mechanical advantages, as will not militate with or frustate, but on the contrary supply chemical requirements. And it should be the business of every proprietor, or occupier of an ill contrived and constructed manufactory, or one that is unsuitably furnished, to make such judicious alterations and improvements, as will enable him to realize both profit and reputation, on the product of his manufacture.

ACCRETION, *a growing to another, an increase, an addition, &c.*

Malting may be termed, a process of accretion and abstraction. The impartation of water to grain, to convert it into malt by the process of germination, does not consist in the mere addition of it in the cistern and the abstraction of it on the kiln; but also in the mechanical operation of enlarging and distending the grain, so as to render it the more capable to receive and reject those principles, which are necessary by accretion and abstraction, to alter its properties, change its condition, and render it a new compound: and also, that by a decomposition of a portion of the water imparted, a portion of the ultimate principles of which such water is composed, may by accretion to a portion of the ultimate principles of which the grain is composed, cause the commencement of, and assist in carrying on the process of germination.

An accretion of oxygen in a state of simple mixture with atmospheric air, as well as the oxygen which is a component principle of such air, occurs to the grain during the process of germination; for the purpose of abstracting a portion of its carbon, and the formation of saccharum.

An accretion of a very large quantity of heated air to malt on the kiln, for the purpose of dessication is necessary, as well as a considerable portion of oxygen therefrom, for the purpose of an additional formation of saccharum, and for the impartation of both colour and flavour.

The term accretion, may also be applied to that portion of the mashing menstruum, which is retained by the malt, over and above the quantity of wort which is withdrawn from it; and the average amount of which, is generally computed at three firkins of the menstruum, to one quarter of malt.

An accretion also occurs to the wort in boiling from the hops imparted, consisting of a fragrant bitter extract, containing a considerable quantity of carbon.

An accretion of oxygen to wort in the mash tun, the under back, hop back, cooling backs, fermenting tuns, cleansing casks, store vats, and sending out casks, occurs, by its transmission, from the atmosphere, induced by an affinity subsisting between such oxygen and the carbon of the wort, and by the action of attraction causing their union.

The accretion of oxygen to wort previous to fermentation, to an extent to cause a proper vinous fermentation, is both absolutely necessary and beneficial; but its accretion may occur to an unnecessary and injurious extent, by an improper mode of, and too long an exposure of it to the atmosphere.

Oxygen, in a state of simple or mechanical admixture with atmospheric air, or such as constitutes a chemical component of air, unites with the carbon of the wort, and the result is the formation of carbonic acid, provided the accretion of oxygen to the carbon, is not to a greater amount than is sufficient for the formation of such an acid; but the danger is, that the accretion may be to an extent sufficient to create acetous acid; and the best means to prevent such an occurrence is, correct mashing heats, a prompt process of extraction, and transference of wort from one utensil to another, with as little exposure to the atmosphere as is possible.

The presence of oxygen in a state of simple mixture with the atmosphere, varies much in amount at different seasons of the year, and much on different occasions during the same season; and therefore, although precautionary measures for the prevention of an accretion of too large a quantity of oxygen, are at all times necessary to be adopted, yet they are more particularly required at such periods, when the presence of oxygen is abundant.

The accretion of oxygen to unfermented or fermented wort, may occur from various sources; and every brewer should be well acquainted with all the sources from which it may occur, and the means to prevent its occurrence to an injurious extent.

The formation of acetous acid in wort, is not only liable to occur from the accretion of too large a quantity of oxygen, but from its accretion too rapidly.

The formation of acetous acid in wort, is liable to occur also from the improper condition of the wort.

Wort placed in the fermenting tun, needs the accretion of yeast, to cause the commencement and continuation of the process of vinous fermentation; a continuance also of the accretion of oxygen, for the formation of carbonic acid and spirit; an accretion of heat to the carbonic acid to convert it into gas; and an accretion, by evolation, of such gas to the atmosphere.

Accuracy.

ACCURACY, *exactness, nicety of attention and performance.*

An imperfect knowledge, or total ignorance of the necessity of strictly attending to the rules of accuracy, in every department of manufacture, in order to obtain the advantages resulting from a correct practice: or indolence, or inability from whatever cause, will ensure effects that must ever prove disadvantageous, and sometimes disastrous.

Some will not learn when they have the opportunity; others have the will but not the means; many, from motives of economy illustrate the adage, "they save at the spigot, and let run out at the bung-hole:" and too large a class are strongly tinctured with prejudice, which blinds their judgments, closes the ear of reason, and enervates and paralyzes their exertion.

Because an ignorant and unlettered person, who has been fortunate enough to have learnt a decent practical system of malting or brewing, or any other branch of manufacture, and is successful in his undertakings; such a circumstance is set down by many, as a certain proof, that science is by no means a necessary adjutor to manufacture. And should they meet with a hapless wight, who is unsuccessful in business, it is a chance, if the cause of all his misfortunes is not laid to the account of that fair auxiliary, and cause the prejudiced practitioner, to bid his pupil to guard carefully against all her bewitching smiles, if he would wish to escape a similar fate.

But prejudice is the result of a want of attention to accuracy: a result is known, and a wrong conclusion is often drawn, for want of accurate knowledge of, or attention to the particulars of the case; and many an excellent invention, important discovery, and admirable system, has been strangled in the birth, because an adverse result has been realized, in consequence of inattention to accuracy in the details of an investigation of its merits; and the condemnation of an uninformed and inaccurate judge, has doomed it and its author, to neglect, to loss, and the dispiriting obloquy of being an unsuccessful schemer.

Take the term accuracy, and apply it to malting; and is it a matter of no consequence, whether grain is steeped with water at one, or eighteen degrees below the temperature at which grain will germinate, or with water at such heat, or such higher, as will render the grain at a right temperature when steeped?

Is it a matter of no consequence, that the room in which the grain is steeped, and subsequently germinates, should systematically be kept at the right germinating temperature? Is it immaterial whether or not the grain is accurately turned or raked, as to time, mode, and frequency? Is it a case of trivial consideration, whether or not the admission of a current of fresh air, is allowed to sweep off the carbonic acid gas, which is hovering as an incubus, over the grain which is sweating under the load of its own excretory exudations, and to furnish a new supply of oxygen, without which germination cannot proceed, and without a sufficiency of which it soon languishes and dies? Is the genial shower which is occasionally distributed from the water pot, of no moment? Is the state and condition of the grain when thrown on the kiln to be disregarded? And will a good maltster dispense with accuracy in that final department of the process? Certainly not! the state of the fire, the time of turning, the colour, the flavor, the treading, and the throwing off, are all operations of accurate and well regulated attention.

If we introduce the term into the brewery, we shall find a strict attention to its dictates, both necessary and advantageous: an accurate attention to the quality, state, and condition of the malt before grinding or crushing; a suitable admixture of malt for ale and porter, as occasion may require; to the indications of the grist, relative to a proper mashing heat; to a correct choice of the first and subsequent extracting heats; to promptitude of process of extraction, consistent with the obtainment, and preservation of wort in a good state and condition, and a full amount of extract; to a proper quantity of hops, proportionate to the quantity of malt extract contained in each wort, and to a right period and circumstances of boiling; to promptitude in the cooling of worts without too long an exposure to the air; to the adoption of a suitable pitching heat, being governed by the connecting circumstances of every occasion; to the administration of yeast that is in a vigorous, sound, and sweet state, and of the proper quantity; to the means necessary to preserve yeast in good condition in hot weather, and to the careful fulfilment of them; to effect a good change of yeast when necessary; to adopt such general measures, as are necessary to prevent the need of acceleration or retardation in fermentation, and to adopt either should necessity require; to cleanse at such a period, as will cause the production of a suitable result, acting under the influence of the various circumstances that govern the judgment; to carry on the process of fermentation in the cleansing cask, on such varying principles as circumstances require; to regulate the suppply or stock in hand according to the demand; to rack neither too early nor too late; to supply customers in quantity according to their consumption, the time of the year, and the condition of the beer; to use the best isinglass, to dissolve it in proper beer, to keep the finings of the right consistence, and to use a proper quantity; to attend well to the state of the casks, and all the utensils of the brewery; and finally, to furnish customers with the suitable directions for the proper management of the beer after they receive it.

All this and much more that I may have omitted, are practical minutiæ, that require the most accurate discernment, judgment, and attention, to render any system of malting and brewing advantageous and profitable; and the more sedulous the attention, the more convincing will be the proofs of the benefits resulting.

ACCUSTOM, *to habituate one's self to a thing.*

Indolence is the great barrier to improvement; it converts a molehill difficulty into a mountain: it magnifies a trivial obstacle into an alpine acclivity, and crowns it with eternal snows of discouragement.

The plains of pleasure and prosperity, that are proffered as the habitable reward to those who with patient and persevering toil surmount them, are not sufficient to induce the moral courage that is requisite to dare the undertaking.

The sterile desert of mental ignorance, the rank weeds of prejudice, enervating indecision, and listless satiety, is the well merited meed of the indolent.

Accustomed to think, to reflect, to judge, and to act, is to prepare a compound, possessing more solvent properties for rugged and lofty difficulties, than ever belonged to the fabulous liquid that is said to have dissolved the rocks, that impeded the march of Hannibal to Italy.

To pass the defiles of science, to arrive at the fair fields of profitable manufacture, is a way much too circuitous, too difficult, and too dangerous for many: they want a "royal road," an experienced leader, a well filled purse, and a palanquin of ease, borne by swift footed runners.

To state that to study natural philosophy and chemistry, in order to become a good maltster and brewer, is absolutely requisite; and still more, that it is insufficient; inasmuch as the human intellect has not yet discovered and developed, much which relates to either, and the knowledge of which we daily need; would be to promulgate an opinion, that would excite the smile of contempt and ridicule of many, and cast up a mound of most discouraging difficulties in the way of others.

But such is the fact, and to shrink from the declaration, from fear of the consequences, would not be to tread the accustomed path, in which truth should ever walk.

Accustom yourself to think what is the cause of every effect, which you by accustomed attention may perceive, should be a maxim, which every instructor should endeavour to inculcate on the minds of those which are placed under his tuition.

If the brewer tells his pupil, that in order that he may know whether or not he has taken a first mashing heat correct, that he must apply a thermometer to the stream of wort, as it runs from the mash tun into the under back, when about half the expected quantity to come off is down; and if he finds the temperature at any point between 144 and 150 degrees, he may take it for granted that it was so; and if on the contrary he finds it above or below, that then he may conclude that it was incorrect, and to an amount proportionate to the extent of the difference in heat, between which it should and does come down; will not the pupil, if he is accustomed to think, naturally enquire, if such is the effect, what is the cause? And if to-day, one particular heat is right, why should not the same be so to-morrow? And if the instructor cannot tell the instructed, what do we think of his knowledge of his business? And if the instructed should say, is it not possible to find out beforehand, what is the right mashing heat upon every occasion, and avoid the consequences of an error; as well as to know by the result, whether or not the right heat has been taken, which it is no consolation to know if it should happen to be wrong? And if the instructor, who has not been accustomed to think, reflect, deduce, and discover, replies, it is impossible, for the person who taught me, was a good brewer and he never knew the means; it is mere theory, which you have no occasion to trouble your head about; all you have to do, is to confine yourself to the practical maxims with which I furnish you, what shall we think of his capacity and suitability as an instructor?

Again; if circumstances render the brewing of wheat malt more profitable than barley malt, or chevalier barley malt than common barley malt; and the mere practitioner, who has ever brewed common barley malt, and by one undeviating system; but who, from report learns, that more profit is to be derived from wheat malt or chevalier barley malt, and he attempts to avail himself of the benefit, by brewing either of those malts by his accustomed system, it would be scarcely possible for him to do other than to sustain loss instead of reaping benefit: and in such case, if we found the practical theorist deriving all the benefit that his enquiries, researches, experimental discoveries, and expansive views, could confer; while the mere practical man is seen to be grasping at gain and clutching loss; what should we then think of his former complacent scorn, when he viewed his brother theorist toiling after knowledge, expending his money, as he thought foolishly, and failing in numerous experiments; and of the bitter taunts and reproaches with which he had formerly assailed him?

But there are mere theorists, as well as mere practitioners, who are ever "grasping at a shadow and losing the substance," pursuing one object until fresh game starts up in their course; chacing every vigorous and fleet footed fugitive, but catching none; wasting their strength in busy idleness, and exhausting all their energies in doing nothing; accustomed to think much and reflect but little; to act energetically, but not to deduce prudently; to think, and to act simultaneously; and then reflect on the consequences, and endeavour to deduce therefrom the cause. The moment the mere theorist conceives an idea, his ardent imagination arrays it with splendid advantages, without reflecting that it may be an illusion; without submitting it to the test of reason, calmly and dispassionately viewing it on every side, and in all its bearings, melting it in the mental crucible, and deducing from satisfactory proofs, whether it is dross or metal: such persons are for ever forcing upon the world, the crude ore of their imaginings, and declaring with the trump of patent fame, that it is sterling metal; and it cannot be wondered, that the credulous dupes who purchase it, and are deceived, should ever after doubt the value of every invention or discovery, if issuing from such, or any other source.

ACETOUS ACID, *sour, sharp, tart.*

In the denomination of vegetable acids, it is usual to divide them into two classes, acetous acid, and acetic acid; the former expressive of the presence of a small or moderate quantity of acid; and the latter, of the presence of a large or very considerable quantity: but there appears to be no definite line of demarcation between the two classes, as relates to the amount of acid in either; but merely an imaginary line, which no two individuals would probably agree in laying down as a right line; and it is perhaps to be regretted, that the author of the terms, did not at the same time prescribe the limited amount of acid, that should decide to which class an acid substance belongs.

The most suitable line of demarcation that can be laid down for the brewer, is the presence or absence of any spirit; classing under the term acetous acid, all beer that has been fermented, and once possessed spirit; but which spirit has partially been converted into an acid; and classing under the term acetic acid, such beer as has thereby lost all its spirit.

The value of beer to a brewer, is proportionate to the presence of spirit, carbonic acid, and unfermented extract of malt, &c. and to the absence of acid, putridity, and feculencies, &c.

The purport of vinous fermentation, is the production of spirit, and carbonic acid gas: and the extent to which vinous fermentation is carried, is proportionate to the ultimate purport of the appropriation of the product.

The distiller endeavours to carry the vinous fermentation to the utmost extent to which he is capable, keeping clear of the acetous and putrefactive fermentations; and avoiding as much as possible the loss of spirit after its creation.

The brewer endeavours to carry on the vinous fermentation to a limited extent, creating a moderate portion of spirit, and carbonic acid; and leaving in his wort a considerable portion of unfermented extract.

The distiller's profit lies in the production of as much spirit, at the least cost as is possible; and the brewer's, in furnishing a compound, that will best please the generality of his customers, and at the least possible cost.

A vino-acetous fermentation is a compound fermentation; the vinous and the acetous proceeding simultaneously together; and such a fermentation is neither profitable to the distiller, brewer, or vinegar maker.

It is not profitable to the distiller, because it diminishes the product of spirit.

It is not profitable to the brewer, because it diminishes the product of spirit and of carbonic acid; and the presence of acid may not be grateful to the palates of his customers; and if it is, it is more profitable and agreeable, as acquired by the commencement of an acetous fermentation, succeeding and gradually following a vinous fermentation, than such as is present resulting from a vino-acetous fermentation.

It is not profitable to the vinegar maker, because the ultimate quantity of acid which his wort is capable of producing, is dependant on the amount of spirit which it is capable of generating; and because the simultaneous production of spirit and acid by a vino-acetous fermentation, is not ultimately so productive of acid, as if the vinous fermentation is first conducted alone to the full extent, and the acetous in regular succession follows, and is conducted to its full extent.

If the brewer's wort is subject to a vino-acetous fermentation, its value is impaired in proportion to the quantity of acid present; and the diminution in the quantity of spirit which has been generated, and which may in part or in whole have been converted into acid; because the creation of acid has prevented the generation of a portion of spirit, and a part or the whole of such spirit as has been generated, has subsequently been converted into an acid.

If the acid derived by wort, which has been subject to a vino-acetous, or an acetous fermentation, succeeding a vinous, is abstracted therefrom; the value of such wort, is proportionate to the quantity of spirit possessed by such wort, and the quantity of unfermented extract which is left after the abstraction of such acid; for although such wort, may not be consumable alone after such abstraction, yet it may be rendered so, by admixture with consumable wort, in appropriate quantity, and managed in an appropriate way.

The value of fermented wort, from which acid has been abstracted, in relation to the quantity of unfermented extract which it possesses, results from its presence, to fulfil the original purpose for which it was left unfermented, or for the purpose of producing spirit by a second process of vinous fermentation, in a state of admixture with unfermented wort.

The quantity of fermentable extract contained in unfermented wort, may be ascertained by the saccharometer; but not so, the quantity of unfermented extract, contained in fermented wort which posesses spirit, inasmuch as the saccharometer indicates the specific gravity, or density of the wort; and as spirit is lighter, and malt or grain extract is heavier than water, so such instrument, which will indicate the quantity of unfermented extract in the double compound called wort, will not in the triple compound called beer.

If wort is subject to a perfect vinous fermentation to its full extent, its density or specific gravity will be nearly or quite equal to water; yet will it possess unfermented extract; and if an acetous fermentation succeeds the vinous, then will its density or specific gravity increase gradually, and to an extent proportionate to the accumulation of acid; and such an increase is attributable to the accretion of oxygen, and to the diminution of the quantity of spirit.

The cause of a vino-acetous or an acetous fermentation, and the formation of acetous acid, is the impartation of oxygen to, and its combination with the carbon and hydrogen of the wort, instead of its combination with the carbon only: and the source of impartation may be from the atmosphere, the utensils, yeast, &c.

The liability of wort to experience a vino-acetous fermentation, from an impartation of too much oxygen to it from the atmosphere, or from an improper combination of the oxygen imparted, with the constituent atoms of the wort, arises from an improper exposure as to time and circumstances, of such wort to the atmosphere; and from the improper composition of the wort, resulting from the use of improper extracting heats: and also, from the atmosphere being surcharged with oxygen in a state of simple mixture, at different periods and days of the year; to the rapid, (and perhaps unavoidable) absorption of which, beer is liable under a variety of circumstances, and more than ordinarily so, when subject to the impartation resulting from an explosive decomposition of electric fluid, which may occur, in what is termed a thunder storm by lightning.

A vino-acetous fermentation, may also result from the admixture of stale beer, with wort previous to, or subsequent to, the commencement of its fermentation in the tun or cleansing casks; or from sound wort being put into utensils impregnated with acid, or by pitching the tun with stale yeast, &c.

If brewers have more stale beer on hand, than is requisite for the formation of finings; or that they can safely mix with new beer, without the risk of offending the taste of their customers, and the liability of increasing their stock, by injudicious endeavours to get rid of it; an abstraction of its acid, at a cost of from sixpence to nine-pence a barrel may be effected, without the impartation of any ill flavor; and a suitable appropriation of it may afterwards be made.

The abstraction or expulsion of acid from beer, and the mere neutralization of the acid of beer, are two distinct and widely different operations.

A variety of carbonates, such as carbonate of soda, carbonate of potash, ammonia, &c. are sufficient to neutralize, but not to abstract or expel an acid; they also impart an ill flavor to beer, a large quantity is required for the purpose, they are far too expensive articles for a brewer's use, and the acid is very soon redeveloped.

To neutralize an acid in beer, wine, &c. is to add a carbonate to either, and the carbon having a greater affinity for the oxygen of the acid, than it has for its own base, (the soda, &c.) unites with such oxygen and forms carbonic acid; and in such a state of combination, the presence of an acid is no longer perceptible, although the greatest portion of the oxygen still remains in the beer.

The result of this operation, is the decomposition of the carbonate administered, and the acid of the beer; and the formation of a new compound, carbonic acid; and the conversion of a small portion of such carbonic acid into gas, which evolates from the beer; and in proportion to the quantity of gas evolated, is the amount of the abstraction of such oxygen, as forms a constituent of the evolated gas: and were it possible by the impartation of such carbonates, to convert all the carbonic acid which is subsequently created, into gas, and cause the evolation of such gas; then would there be a complete abstraction or expulsion of the whole of the oxygen, forming a constituent of the acid from the beer, and no residue left for subsequent redevelopement. But heat in sufficient quantity is wanting, to convert the whole of the carbonic acid generated, into gas, and the decomposition of the carbonate and the acid, will not afford a sufficiency to effect the purpose, and consequently, but a small portion of the oxygen is expelled.

But such is not the resulting effect of an administration of the ingredients which I prescribe, inasmuch as they furnish a much greater amount of carbon, combined with a much purer, and smaller quantity of the base; and supply a sufficient quantity of heat by decomposition, to convert the whole of the carbonic acid generated, into gas; and by the evolation of which, the whole of the oxygen, which had previously formed the constituent characteristic of the acid, is expelled from the beer: and thus by a judicious combination of ingredients and in correct proportions, the whole of the oxygen, (the cause of acidity) is expelled, no ill flavor imparted, and the purpose is accomplished at a very small cost.

ACRID, *of a hot, biting taste, hot, bitter, sharp.*

Acridity is a malady, to which brewing utensils are subject, more particularly cleansing casks, and such casks as are sent out, and too often, injudiciously left without cork or bung, when emptied; the interior subject to the access of air, and often exposed to the sun.

The cause of acridity, is the impartation of oxygen from the atmosphere, to the beer that adheres to the interior surface of the cask, and penetrates into the pores of the wood; and the result is the formation of acetous acid.

The small quantity of beer which is thus diffused throughout an extensive surface, is favourable to the rapid formation of acetous acid; and if the process is aided by an exposure of the cask to the rays of the sun, or to an atmosphere of high temperature, the rapidity of the formation is much accelerated.

The lees or sediment of beer, which is generally left in the cask, is from its composition, subject to an acetous fermentation, more rapidly than the beer which adheres to the surface, as it possesses more of the acidifiable base; and to the results of a combination of oxygen, with the peculiar base of such lees or sediment, may be attributed, the characteristic distinction between the smell and flavor imparted to new beer which is put into casks, in which such a fermentation has occurred, from that which results from the administration of pure acetous acid to new beer: and the terms acridity and acidity, are very appropriate, and expressively distinctive, to denote the condition of those casks or utensils, in which either peculiar fermentation may have occurred.

As relates to this malady, we are again forcibly reminded of the maxim, that "prevention is better than cure." Prevention to a very considerable extent may be effected, by prompt ablution of the utensils when emptied, or by preventing the access of atmospheric air to the interior, and by not placing them in a heated atmosphere.

But as prevention is not always possible, even under the best regulated system of conducting business; and particularly as relates to casks in the care of publicans and others; it is quite necessary for the welfare of every brewer's business, that he should be possessed of the most effectual and economical remedy for the evil, and that it should be applied in every case of need: and for such purpose, I have found that a cheap chemical fluid is the most efficacious, as it is not only capable of abstracting the oxygen from the surface of the wood, but also of penetrating into the pores of the wood, and extracting the oxygen from the utmost recesses, to which it may have obtained access; and in addition to the property which it possesses, of divesting utensils of acidity, and acridity, it also posseses disinfecting properties, and is an effectual curative of must, fox, &c. while it possesses the further merit of abstracting tanin from wood, and to a depth proportionate to the strength of the liquid, and the facilities afforded for its penetration; and is found to be the most suitable agent, for the seasoning of new wood utensils and casks.

ADAGE, *a proverb, common saying.*

Manufacture as well as morals, are much indebted to proverbs for improvement.

The several proverbs appertaining to each peculiar branch of manufacture, and to business in general, often induce reflection and inquiry, as to the cause of their origin, and the propriety of their application; which sometimes leads to the deduction of some useful suggestion, which forms the basis of important improvement.

A few proverbs relating to the malting and brewing business I will mention, and endeavour to furnish an explanation of their meaning, and the useful inferences which may be drawn from them; and if dressed in the garb of homely rhyme, the reader will probably excuse the attempt to render them more impressive by such means.

If grain in the field, or elsewhere gets the swell,
Instead of the cistern, 'twill not malt so well.

When the growth of the grain in the ear, is fully completed, and the vitality of the plant ceases, or a short period before its cessation, the stalk is cut asunder, by which the fluid nutriment had been conveyed, for the formation and accretion of such grain. and what is then termed the straw and ear, are conveyed together, and deposited in some suitable situation and way, as is requisite to preserve it for future appropriation and consumption.

Should the grain during its formation, growth, and subsequent dessication, (termed ripening) be aided by suitable weather, and advantageous circumstances, and finally be conveyed to a place of safety in good and dry condition; the maltster may ultimately obtain it in a fit and proper state for the production of good malt; but if on the contrary the weather is cold, wet, and stormy, during the formation, growth, cutting, and housing of the grain, it will come to the maltster's hands in an unpropitious state for the process of malting.

But irrespective of the state of the weather, it sometimes occurs, that grain which may have experienced a full and favorable growth, may be cut and housed, previous to its dessication to a proper extent, and consequently to the formation of its constituent substances, in the relative quantity and proportion, to constitute it of the proper malting quality.

The purport of malting is to convert the fecula, or starch of the grain into saccharum, and the gum and gluten into fecula; and by the analysis of unripe and ripe grain, it will be found that the effect of ripening, is the gradual transformation of one substance into the other to a limited extent, for the purpose of effecting the complete and mature developement of the vital functions in every seed, and for the formation of a stock of nutriment to sustain and support those functions, as soon as they are awakened into life: hence to cut, carry, and house grain before such an effect is produced, is ultimately to furnish the maltster with grain, whose germinative functions are incomplete, and the transformation of whose internal substances have not been effected to the extent of capability; consequently he has to perform with inefficient functions and insufficient nutriment, a greater task of transformation with inadequate resources.

The practice of cutting, carrying, and housing grain previous to its being fully ripe, is sometimes the result of fear, lest propitious weather then experienced should change to foul; and that to lose the present chance, might be productive of greater evil, by having to cut, carry and house the ripe grain in wet and unpropitious weather; but the motive is too often an avaricious one, for as well ripened grain, does not weigh so heavy as that which is incompletely ripe, or look so plump and fair, nor measure near so well, the temptations all lie on the side of immaturity.

Such grain may be said to have preserved the swell, by a reservation of those fluid secretions, derived by medium of the foot stalk of the plant, &c. and the appropriation of a portion of which, by accretion to the internal substances of the grain, and the transpiration of the residue from the surface of the skin, was prevented by the premature cutting and ingathering of the crop.

This pernicious practice, is much promoted by the injudicious system of purchasing grain for malting, by a warrantry of some definite weight per bushel; and it is a usual practice for the shipping agent, to offer a cargo of grain warranted to weigh so many pounds per bushel, at a price corresponding to the weight, and the weight alone is depended upon as the criterion of the quality of the grain; and the shipping agent is strongly tempted to make up an assorted cargo, by the purchase of any grain that will weigh the warranted weight.

The farmer too, finding that the heavier the grain is the better it sells, and the better the price he obtains for it, is strongly tempted to furnish heavy grain, by its production in three or more ways; first, by a premature ingathering; second, by an ingathering regardless of wet weather, or a subsequent careful preservation from the absorption of moisture; and third, by its growth on stiff, wet, and heavy land.

By the second method, whether it occurs from design, from carelessness, or unavoidable circumstances, the swell in such case may be said to result from impartation; for although the grain may have been well ripened, and consequently the vital functions fully developed, and the transformation of substances completely effected; yet having subsequently absorbed moisture, and perhaps to an amount sufficient to excite the vital functions into life, but not enough to carry on the process of germination, they are injured by the partial, feeble and insufficient excitement; and the small amount of life which has thus been kindled, without any accompanying resources for its continuance is soon extinguished; and when such grain is submitted to the malting process, the extinct life cannot be revived, a putrefactive ferment ensues among that portion which has been subject to a partial and suspended growth; while the uneven and varied extension of the germinating progress of the rest, furnishes a mass at the termination of the process, composed of unmalted, semi-malted, malted and putrified grain.

By the third circumstance, whether occurring from design or necessity, grain which is grown on stiff, wet, and heavy soils, generally possesses much more gum and gluten, than such as is produced on light and dry soils; and when the former grain is purchased by the maltster, in relation to its superior weight, without any reference to its quality, he pays the highest price for the most inferior; and in the process of malting, he has to accomplish the hard and difficult, if not insuperable task, of transforming an extra, and large amount of gum and gluten into starch, and starch into saccharum, within the limited period of the process; and at the termination he has the mortification to find, that his floor of grain exhibits germination just begun and finished, and every grade between.

The inconsistent system of purchasing and paying a price for grain, in proportion to its weight per bushel, without submitting its malting qualities to the usual tests, has arisen from the circumstance that a bushel of well grown, well ripened, well housed, and well cleaned malting grain, will weigh heavier than such as is distinguished by any, or the whole of the opposite qualities and condition; and as grain is generally bought by sample, and if by bulk it cannot be accurately examined throughout; it has become a custom to require a guarantee of a definite weight, as the least of the several evils to which a purchaser can be subject, in trusting to the honor and integrity of the seller.

But the purchaser should not surrender his judgment, to an indiscriminate purchase by weight alone, but should endeavour to obtain grain for malting which has been grown on a light dry soil; possessing much fecula, and but a small amount of gum and gluten; the growth and ripening of which has been fully completed, which has been well harvested, housed, preserved, sweat in the mow, thrashed without much bruising or breaking, well cleaned and which is of good weight.

Adage.

If barley has not sweat in the mow,
It will not make good malt somehow.

Practical experience has sufficiently proved that if barley is steeped and converted into malt immediately it is cut, or very soon afterwards, or previous to its having sweat in the mow, that it will not make so good malt as when it has; and more particularly after a wet or cold harvest.

At first view it may appear to be of little import, if grain does not come very dry to the cistern, and it may be imagined that a little shorter steeping may be a sufficient remedy: and so it might, if nothing but water was required to be abstracted, and that such as was retained by the grain, might be considered as an equivalent to an absorption of water to a smaller amount: but such is not the case, inasmuch as the sweating in the mow, is not an evaporating process of water or any other fluid, but a gaseous transpiration, resulting from an organic change in the internal substances of which the grain is composed, and which it is necessary should be effected, previous to its being subjected to the process of germination; and which changes are necessary to effect the full developement of the vital functions of the seed, and to provide a suitable internal nutriment, and in sufficient quantity to aid the commencement and continuation of the process of germination, from the first to its final stage.

Sweating in the mow, may then be considered as an artificial process of finishing off the ripening of grain, which has not been effected in the field, and which seldom can be, in this cold and variable climate: and although the weather might sometimes prove propitious, yet such is the uncertainty of its continuance, that the farmer prefers taking the first favourable opportunity that may present, to cut and house his grain, rather than risk the chances of an unfavourable change, for the sake of endeavouring to effect a full completion of the ripening process in the field.

But even if time was allowed, and propitious weather concurred in fully ripening the grain in the field, yet would sweating in the mow be necessary, although to a minor amount, inasmuch as under the most favourable circumstances, much unripe grain is ever mixed with the ripe, and the sweating process is needed to finish off the unripe, and bring them forward to a state and condition, ready for the commencement and continuation of the process of germination together.

The damp, cold, and variable temperature of the atmosphere of the British climate, renders it peculiarly necessary, that the growth of grain intended for the process of malting, should be sown on a light dry soil; and that the situation of such soil, should be in a sunny aspect; that the seed sown should be of good malting quality, and should be in a condition to commence germination evenly together; and that the vegetation of the whole should proceed in equable concert; that it should not be harvested until fully ripe; and that it should not be malted until it has sweat well in the mow.

The ripening of grain in the field, is an impartative and abstractive process; but in the mow, an abstractive process only as relates to heat: in the field the ripening is effected by the impartation of oxygen, aided by the calorific rays of the sun, and the abstraction of carbonic acid gas, for the purpose of creating starch and saccharum in the grain, in order to form a store of nutriment, ready for the support and sustenance of the vital functions, as soon as they are excited into action. But in the mow, the access of the atmospheric air, which is necessary to convey and furnish oxygen to the imbedded grain, is difficult, slow and of inconsiderable quantity; the impartation of heat to it is none, and the gaseous abstraction experiences much obstruction.

Although no impartation of heat to grain while sweating in the mow occurs, yet the presence of much heat is manifest, and the amount is proportionate to the unripe state of the grain when placed in the mow, and to the humidity of the grain and straw when cut and stacked together: but this heat is the result of a decomposition of a portion of the internal substance of the grain and straw; the decomposition the consequence of humidity; and the effect, the liberation of latent heat and its conversion into a state of activity; and when such heat is liberated to a great amount, and the transpiration of resulting gas is not of corresponding rapidity, the grain becomes what is termed "mow burnt," which causes a destruction of the vital principle and consequenly it is incapable of germinating.

From these observations it will then appear evident, that sweating in the mow, is only a necessary measure to complete the ripening process which has not been finished in the field: that the greater the extent to which such process has been conducted in the field, and the less that is required to be effected in the mow, whether from the nonabstraction or impartation in the field, the better: that if grain is stacked too unripe, or possessing too much humidity from whatever cause, the conversion of latent heat into active, resulting from decomposition, will be so great, that if the transpiration of such heat is not of proportionate rapidity to the conversion, the grain will be mow burnt: that the larger the dimensions of the mow, and the less the facilities for the transpiration of such heat, resulting from its situation as well as size, the greater is the liability of the grain being mow burnt: and that the greater the extent of the sweating process, as a succedaneum to the ripening process in the field, the less is the value of such grain, inasmuch as ripening in the field, is an impartive and abstractive process, while sweating is nearly or quite an abstractive process only.

But with the possession of the requisite knowledge, and the adoption of the utmost care, in selecting grain of the most suitable quality for malting, yet there are times, seasons and circumstances, that cause or compel the purchase of such as is cold, damp, steely, and in an unsuitable condition for the purpose; and the adoption of artificial remedies by the maltster, becomes imperatively necessary to the production of as good malt as art will enable from a bad material.

To malt in may, is to go astray.

This proverb takes its rise from the well observed fact, that in the month of may, (as a general rule) the process of germination is too rapid, and the results are not productive of good malt.

The cause of such an effect, is not to be attributed to the high temperature of the atmosphere in such month alone, but conjunctively with the presence of a large quantity of oxygen in the atmosphere in a state of simple mixture, resulting from its transpiration from the leaves of vegetative substances, and the impartation of which to grain in a state of germination, is facilitated and accelerated by a high atmospheric temperature; and the impartation being too rapid and too abundant, the process of accretion of oxygen to form saccharum, and to abstract carbon in the form of carbonic acid gas, does not proceed in that symmetrical order and unison, as is necessary to produce satisfactory results; and hence malt manufactured at such a period, experiences too rapid an evolution of the root and acrospire, and consequently a waste of the saccharum which is created, and too great an evolation of carbonic acid gas, wasting those internal resources which should be left for developement, conversion, and appropriation in the mash tun, and in the process of fermentation.

If the high temperature of the atmosphere, was the only cause of the effects experienced and described, and not its oxygenated condition in conjunction; it might be possible by artificial means and mechanical contrivances, to obviate the results of a high atmospheric temperature and to malt all the year through; but practical endeavours and results have proved, that not only is the process of germination disadvantageously effected at an unseasonable period of the year, but that dry grain gradually loses its germinative properties, by an exposure to an oxygenated atmosphere; and hence grain that is kept over from one season to another, is found to be defective in its germinative properties, and is not convertible into malt of so good quality the second season, as it was or might have been the first.

It is said, and truly said, "there is a time and season for all things," and the truth of it is satisfactorily verified in the process of germination; for providence having appointed a natural and proper period for its operation, a proper temperature of the earth as the matrix in which it should occur, and a proper condition of the atmosphere as an auxiliary to its performance; it is evident without further demonstrative proof, that such is the proper period for man to select for the accomplishment of his imitative work; and that to produce as fair a copy as is possible, he cannot do better than to study well the original, and to avail himself of all approximating, as well as similar circumstances and conditions, that are necessary and well adapted to the purpose.

The process of vegetation and germination are divided by a distinctive line of demarcation; the latter terminating and the former commencing at the period, when the plumula or acrospire protrudes from the body of the grain, and requires a portion of atmospheric aliment to sustain its growth by accretion, and to enable the developement of the future stem and all its subsequent appendages; and we cannot too much admire the ordinary dispensation of suitable weather, for the purpose of preparing the seed for the commencement and continuation of the process of germination, in the gradual transition from the fervent heat, that is necessary to ripen and fully mature, unto the medium heat that is necessary to unfold and excite into action the principle of life; down to the extreme cold which is necessary to retard the forward species and individual seeds, in order to give time for the required advance of the backward, with many a genial shower at intervals between, to aid the weak and feeble in their course, until all have comparatively reached the vegetating point, when a gradual increase of atmospheric temperature occurs, favoring the developement of each future plant.

To malt well the maltster is not in position,
Until his house is got into working condition.

It is usual to expect, that the first two or three wettings or steepings of grain, at the commencement of the malting season, will not make so good malt as succeeding steepings; and the assigned reason is, "because the house is not got into good working order;" and talk to what maltster you may, you cannot obtain a more satisfactory reason.

From such a conclusion, founded on practical observation and experience, we may infer, that a house requires to be in good condition, before good malt can be made in it; and that the first two or three steepings render it so, but at the sacrifice of their own quality.

If then the grain in a state of germination, renders a malthouse which is not in a fit and advantageous state for the process, quite fit; it is quite plain that some emanation from such grain, must produce the requisite effect; and the query is, what is it that proceeds from it, that accomplishes the purpose? The obvious and correct reply, appears to me to be, heat.

Let us then suppose, that at the commencement of the malting season, the weather is cold, or perhaps what is termed mild; and the temperature of the malting floor, and the atmosphere within the room, is below the advantageous germinating heat; the effect must be, that a considerable portion of that heat which is a constituent of grain, and is blended with its ponderable atoms, for the purpose of being rendered active, by a decomposition of the internal substances, and for converting the carbonic acid, resulting from the impartation of oxygen from the atmosphere to the carbon of the grain, into carbonic acid gas, and rendering it necessary for evolation, must necessarily pass to the floor, the atmosphere, and every substance composing the room, as induced by the law of equable diffusion; instead of accomplishing its destined purpose, the conversion of carbonic acid into gas.

It hence must follow, that the conversion of carbonic acid into gas, and its evolation to a proper extent, and with sufficient rapidity does not occur, in consequence of the misappropriation of the latent heat of the grain to a considerable extent as soon as it is rendered active: and thus by such means the house is brought into good working condition, at the expence of an incomplete and ill performed process of germination, by the first two or three steepings. Such being the case, it may be a profitable enquiry, if it is not more economical to raise the temperature of the room to a right point previous to steeping, rather than sustain the loss resulting from the manufacture of a certain quantity of inferior malt; also what that temperature should be, and the best economical means to effect it; and likewise, if any other measures can be adopted as an auxiliary to the purpose of "rendering the house in good working condition.

When beans and pease are out in flower,
Expect the beer will soon go sour.

There are few brewers I believe, who do not yearly experience those results, which prove the correctness of the data on which this adage is founded, in the tendency which they discover in their beer, to turn stale in a very short period after it is brewed, at the time that beans and pease are in full bloom.

Whether the cause is to be attributed to an emanation from those plants, or from others which are in a state of vigorous vegetation at the same period, it is perhaps impossible to discover; but from the knowledge we possess, that the absorption of oxygen is necessary to an acetous fermentation, and that all substances in a state of vegetation furnish large quantities of oxygen to the atmosphere; and that wort previous and subsequent to fermentation, rapidly absorbs it; it is fair to presume that an absorption of oxygen to an extent sufficient to cause the acetification of beer, is the result of a transpiration of oxygen from vegetables and plants in general, and that such transpiration occurs most abundantly, when vegetation is in the most vigorous state; and that the bean and pea plant when in flower, may contribute largely to the emanated fund.

To guard as much as is possible, from the injurious effects resulting to beer brewed at such a period, a quick process of brewing, with the shortest and least exposure of the wort to the atmosphere as is consistent, should be adopted, and a prompt consumption of the products should be effected.

If the water is hard,
'Twill solution retard.

What is termed hard water, is such as is impregnated with acid, derived from some substance in its passage from the original source to the well.

There are two sorts of chalk, one called sulphate of lime, which imparts acid to water; and the other carbonate of lime, which abstracts acid from it, or converts the acid which it possesses into carbonic acid, by an impartation of its carbon to the acid of the water, the first rendering it what is termed hard and the second soft.

A transmission of immense volumes of water from the surface of seas, lakes, rivers and the earth to the atmosphere, is momentarily occurring by the process of evaporation; and which is again precipitated in the form of rain, snow, hail, &c. and with the exception of such impurities as are blended with it in its descent, it falls to the earth free from the admixture of acid, and is what is commonly termed soft.

In its progress through the various strata of the earth, it is liable to abstract acid from a variety of substances, and thereby become what is technically termed hard; or in its progress it may not meet with acid, and consequently remains soft; or it may pass through substances that may abstract the acid which it had previously received, or it may flow over substances which may impart to it carbon, and which uniting with the acid which it had previously obtained, carbonic acid may be formed, and the acid being thereby neutralized, the water is rendered soft.

In addition to the two sorts of chalk that either render water hard or soft, a great variety of substances will variously affect the quality of the water, by solution and chemical admixture therewith, which may occur in its progress through the interior of the earth, as metals, minerals, salts, &c.

Water may appear perfectly pure to the eye, and be deemed so by the artificial observer, because it may be colorless and brilliantly transparent; but such water may hold in chemical solution and admixture, a variety of substances all of which may be precipitated or separated by proper chemical agents.

Water may be perceptibly impure, by an admixture of a variety of substances with it, in a state of simple or mechanical combination, from all which it may be freed by depuration and filtration.

Water both chemically and mechanically pure, is the best menstruum for solution for the brewer's, distiller's, and vinegar manufacturer's use; and in case it cannot be obtained in such a state, it should be a subject of enquiry, what are the substances which are combined with it, and what are the means by which they may be separated; how far their presence is inimical to solution and fermentation; and whether the advantages of its purification, are commensurate to the cost, labour, trouble, and inconvenience, &c.

In the expeditious process of brewing referred to, and the details of which are furnished in my Practical Treatise on Brewing, a considerable quantity of distilled water is furnished as a menstruum for solution, without any extra cost of fuel; and in fact, such process requires the consumption of a smaller amount of fuel, than is consumed in the accustomed mode of brewing, and the supply of a large quantity of distilled water for mashing, &c. is but one among many of the advantages which the system supplies.

The presence of acid in water, which is used as a menstruum for malted or unmalted grain, or any fermentable material, renders the resulting wort or compound, liable to a vino-acetous fermentation, proportionate to the quantity of acid present.

Either partially or totally, the malt will be set,
If with water too hot or too cold it is wet.

To set the malt or set the goods, are technical expressions, used to denote the state of the malt in the mash tun, which being mashed with water or return wort, that is either too hot or too cold, the menstruum and the malt form an homogenous compound, so that no part of the menstruum can be withdrawn from the malt in the state of wort.

Between the two points of temperature, "too hot or too cold," there is an extensive range of heat, and a perfect or correct first mashing heat lies somewhere between; and those who deviate most from that point either above or below, are the most unsuccessful in effecting a solution of extract in sufficient quantity, and of properly compounded quality.

Few brewers are unacquainted by personal experience, with the state of malt when totally set, and the consequent loss sustained: but many are, or seem to be, totally unacquainted with the fact, when it is partially set; although many scarcely ever go through a brewing without its occurrence, and resulting loss. If malt does not yield a good and large product, such persons as know nothing about a partial setting of the goods, in consequence of not having taken a right first mashing heat, attribute the inferior and short produce of extract, to the bad quality of the malt.

If there was an invariably right standard heat, either for water or return wort, as well as a perfect heat, at which the best solution of malt extract, and the obtainment of the largest quantity could be effected; the discovery of it would be of the highest importance to brewers; and once made, and communicated to the public, its invariable adoption, would ensure to the fortunate possessor, the most profitable results, as relates to the process of extraction.

But that which does not exist, cannot be discovered. Yet there is a perfect first mashing heat, but it is a variable one, and may be said to be fugitive, the same heat scarcely ever being advantageously applicable to two successive brewings from the same malt.

In common experience, I have discovered that a perfect first mashing heat, is variable to an extent of 30 degrees during the period of a year's general practice; and if correct in making such a statement, how far many in their usual practice must occasionally be from taking a right mashing heat, is or should be best known to themselves: but the fact is demonstrable, and those that will not believe it, and those that doubt and will not learn; and those that believe and will not convince themselves of the fact, and make the necessary sacrifice to obtain so valuable and important a branch of knowledge, must consequently sustain the annual loss to which they are more or less subject, in proportion to their adhesion to one invariable heat, or their successful variations from it.

The practice of many maltsters, brewers and others, renders them liable to a well merited censure, for after having lost the obtainment of much profit, by a most wasteful system of conducting their business; if at the end of the year, they realize little or much nett profit, they sit down contented, without any enquiry, whether such is, as it should have been, had they pursued a better system; and in fact, many brewers not only do not know whether or not they obtain as much extract from a quarter of malt as they should get, or as others get; but they do not know what they get themselves.

As a measure of policy and self interest, every one should endeavour to learn what others obtain, and to know what he gets himself; and if he finds that any one obtains more than himself, it should be his business to learn, if the cause is to be attributed to a difference in the quality of the grain bought, or the system of converting it into malt; to the quality of the malt made or purchased, or the system by which it is brewed, and having discovered the cause, he should endeavour to learn the value of the difference in the result, and then count the cost of deriving the means to produce a similar effect: and having set the cost against the gain, it will then be for him to judge, if the proffered advantage is more than equal to the required cost of the information, which is necessary to be obtained to enable him to realize it.

Thus we will suppose that a brewer brews one thousand quarters of malt per year, and he finds by reference to his brewing journal, that the average product of his malt has been 75lbs of extract per quarter of malt, as per fermenting tun gauge of boiled wort; or the total amount of the produce of the 1000 quarters in boiled wort, is 75,000lbs.; and he hears and believes that another brewer obtains an average extract of 85lbs. per quarter, or 85,000lbs. of extract from 1000 quarters; and that the cost of a quarter of malt to each is 60 shillings; the query then is, how much more profit does one brewer get from a 1000 quarters of malt than the other?

The reply to this question, may be ascertained by working out the following statement by the rule of three. If 75,000lbs. of extract are worth 3,000 pounds sterling, what are 85,000lbs. worth? Answer 3,400 pounds sterling. And surely it is worth every brewer's while to enquire, if there is so great a difference in the produce of his malt, or an approximation thereto, and that of any other brewer's; and if so, to expend a few pounds in the acquirement of that knowledge, that may not only enable him to save the difference between what he does and might get upon the 1000 quarters, but upon whatever he may have occasion to brew in future.

When the first wort's half down, its heat will declare
If a right mashing heat you happened to choose;
But if wrong, 'twill not tell you how to repair
The mischief you've done, and what you will lose.

It is the practice of many brewers, I believe, invariably to take their first mashing liquor at one heat all the year round, regardless of the quality, state, and condition of the malt, and other contingent circumstances, and trouble themselves but little about the consequences, conceiving that whatever may be the result, whether good or evil, as they know no other method they have no alternative, but to take the chance of what may occur, and think that "what cannot be cured must be endured."

It is the practice of others, who have a greater yet incomplete knowledge of the subject, to make such variations in their first mashing heat, as their judgments' suggest is necessary, which are governed by the color of the malt, whether free or steely, dry or slack, high or low ground, &c. all which is well so far as it goes, but a much more important consideration than either, which is the temperature, &c. of the malt, at the time it is about to be mashed, is for want of a proper knowledge of the subject altogether overlooked.

Those who are governed by the color of the malt, appear to possess some vague and indistinct idea, because malt that is dried high and must have received more heat on the kiln, than such as is dried pale, that consequently it possesses more when about to be mashed, and therefore on that account, a lower mashing heat is requisite for the high dried than for the pale malt: but such is not the fact, for the actual heat of the malt at the time of mashing, bears no relation to the amount of heat imparted on the kiln: and although high dried malt of the same temperature as pale malt at the time of mashing, may require a lower mashing heat, on the ground of other considerations than its present heat, yet there are an abundance of occasions and circumstances, when it may be necessary to mash high dried malt, at a higher temperature of the menstruum than pale malt.

The first and most important step in the process of brewing is the choice of a proper heat of the menstruum for the first mashing, as the quality and quantity of the extract, obtained in the first, and every succeeding wort, is dependent on the correctness of the choice, or the approximation thereto; and a knowledge of the means to ascertain it upon every occasion, should be in the possession of every brewer; and for a trivial remuneration compared with the advantages resulting from its obtainment, I propose to communicate it to such as are desirous of possessing it.

If the wort runs down fine, with a deep frothy head,
'Tis a sign that the mashing has surely well sped.

Such, when it occurs, is another subsequent proof of having done well, in taking a right mashing heat, and in having properly conducted the process of extraction from malt of good quality, and properly prepared for the purpose; but the presence of such a proof to day, is no consolation for its absence to-morrow, but is rather an aggravation to the mortification, if the same means have been used to produce a similar result, but which effect a dissimilar.

The first step taken wrong, leads to irretrieveably injurious consequences, and which no subsequent remedy will rectify; and the effect will be evidenced by the production of an improperly compounded wort, a deficiency of extract, and a bad fermentation, with the liability of subsequent acetification.

As an illustrative and corroborative proof of the correctness of such an opinion, I received a letter a short time previous to penning this, offering from 150 to 200 barrels of stale beer at fourteen shillings a barrel delivered free, from a distance of about 50 miles, the original density of which was 23 or 24lbs. per barrel, and the acetification of which, the writer attributed to the taking of too low mashing heats, and an improper fermentation.

Had the brewer been in possession of my tables for mashing heats, and the accompanying information, he might probably have been spared the mortification of making such an offer, all the resulting inconvenience, labour and trouble which it had caused, and the great loss that inevitably must have been sustained by it.

> **Grains that fatten a hog, may starve a poor brewer,**
> **And produce him a beer but fit for the sewer.**

The measures which are necessary to be adopted to obtain a large quantity of extract from malt, are happily such as are necessary to obtain it of a good quality; and if rightly pursued, the whole of the obtainable extract may be advantageously appropriated; but if on the contrary, an improper mode of extraction in the early stages of the process are adopted, a rejection of such as is obtainable in the latter stages, follows as a necessary consequence; for if a solution of the several substances of which malt is composed, is not effected in right proportions, no subsequent remedial heats will undo, or compensate for, the mischief which has been done; and that which was begun in error must be continued in error; and in order to prevent an addition of too much gluten to the first worts, in which an improper quantity may have been dissolved by imprudent heats and other measures, it becomes necessary to lose much valuable extract, by a rejection of the latter products, for the sake of avoiding the addition of more gluten, of which he may already have obtained too much.

The primary purport of solution by infusion, is to obtain all the saccharum which malt contains ready formed, and all the fecula or starch, as a fund of material for the formation of saccharum by ulterior proceedings; and the secondary object is, to dissolve as much gum and gluten as is necessary for the purpose of finally converting the fecula into saccharum, and the saccharum into spirit: and to conduct the process in due order and with desirable effect, the heat of the menstruum and the several circumstances and measures attendant on the first and second infusions, should be correctly taken and conducted, in order to dissolve as much saccharum and fecula, and as little gum and gluten as is possible: and having done such, it will still be found that much fecula remains intimately blended with the gum and gluten, and having abstained from the solution of much gum and gluten in the two first infusions, more room is left for the solution of such as is unavoidable, in the search for the residue of the fecula; and although the solution of a certain portion of gum and gluten is absolutely necessary to ensure a proper vinous fermentation of the saccharum and fecula, yet it is also certain, that the whole of the saccharum and fecula contained in malt, cannot be dissolved without the solution of more than a sufficiency of gum and gluten; and the danger and difficulty is, that the whole of the former may not be obtained without a redundancy of the latter.

The most important error committed by the majority of brewers in the process of extraction, is the solution of too much gum and gluten, and too little saccharum and fecula; causing the presence of an evil as relates to superabundance, and the absence of a benefit as relates to deficiency; while at the same time from other errors in practice, and the need of suitable mechanical conveniences, they increase the evil instead of diminishing it, and diminish the good instead of effecting its increase, subsequent to the process of extraction.

Wort boiled insufficient will drink raw and thin,
And cause an acetous and foul fermenting.

The quantity of gluten dissolved in the process of malt extraction, is much too great under the most favourable system of conduction, from malt of the best quality for the required purposes of fermentation; and the presence of more than is needed, is not merely negatively useless, but positively injurious, inasmuch as the quantity in excess, renders the wort liable to a vino-acetous fermentation, and to a variety of subsequent disorders, such as may be described under the heads of raw, thin, mawkish, acid, foul, grey, ropy, &c.

But as the solution of gluten in excess is unavoidable, under the most favourable system and circumstances, there is a wise provision for its abstraction to a right extent, by the process of boiling the wort, which has the effect of coagulating the gluten, in proportion to the rapidity and period of ebullition: and although this suitable provision is made for its abstraction to a right extent, it is not wise to presume upon such a remedy, and consequently to become indifferent as to the quantity obtained by solution in the mash tun, inasmuch as it may be productive of much injury to the wort before it reaches the copper, and if brought there in excess, it may cause much loss of fuel, time, wear and tear, as well as chemical injury to the wort to abstract it.

Providence has provided a suitable remedy for every unavoidable evil, but none for such as are avoidable.

The presence of gluten in wort in excess being injurious yet unavoidable; the means of abstraction being by coagulation effected by boiling; and its presence in sufficient quantity for the purpose of effecting a vinous fermentation being absolutely necessary; the subject of boiling as relates to rapidity and time, must necessarily be one of paramount importance and consideration.

Wort too long exposed to a sultry air,
More mischief will get than time can repair.

Few brewers think at all, or so much as they ought to do, about the chemical injury which worts sustain, by laying so long exposed to the air in spring and summer, as the personal inconvenience they experience, as relates to time and labour, and sitting up late, or getting up early, as a resulting consequence: and thus, the evil which is of the greatest consequence, is altogether overlooked, or but little thought of, while the secondary consideration is made the sole or primary inducement to the obtainment of a refrigerator, or the adoption of other measures to prevent the occurrence of the evil; and it is to the absence of a chemical knowledge of the subject of brewing, that we must attribute this want of chemical consideration, and the preference which is given to mechanical advantages. And instead of the chemical results being a primary feature in the calculation relative to the cost of a refrigerator, it is either altogether excluded or is but of a secondary consideration.

Brewers cannot see the process of absorption of oxygen by wort from the atmosphere, during its progress through the several stages from the mash tun to the fermenting tun, and therefore know nothing about it, unless informed by those who are acquainted with the fact, or learn it from the works of those authors who have written on the subject; and as such an operation must be either beneficial or prejudical, or both, it is a subject deserving the best attention of every brewer; and no reasonable pains or expence should be spared, to endeavour to obtain all possible information respecting it.

Without absorption of oxygen to a sufficient extent, fermentation cannot take place; but if it occurs to a greater amount than is necessary for the purpose of ensuring a vinous fermentation, an acetous in conjunction with the vinous will take place.

The shortest possible period in which the transition of wort from one vessel to another can be effected, in the most rapid process of brewing, is quite sufficient for the absorption of enough oxygen by the wort, for the purpose of vinous fermentation; and during the spring and summer, the chief difficulty is, to prevent the absorption of too large a quantity; and as an auxiliary to other measures of prevention, the refrigerator furnishes admirable means of effecting the object.

A change of yeast and change of seed,
Both wort and soil doth often need.

It is a fact well known among brewers as well as farmers, that a change of yeast is necessary to cause a good fermentation, as well as that a change of seed is occasionally necessary to the production of a good crop: but the cause is not so easily discerned as the effect is observed.

Should yeast become sour or putrid, it cannot of course be fit to use for the purpose of effecting a vinous fermentation: and should its fermentative powers be partially or totally destroyed, it becomes partly or totally inefficient to produce a good and vigorous fermentation. Yeast kept in an improper situation, in too great a bulk, or for too long a period, is liable to a certain acetification, putridity, or loss of fermentative power. The cause appears to be the absorption of oxygen from the atmosphere, and abstraction of carbon from the yeast.

But independent of the necessity of a change of yeast, resulting from either of the causes mentioned, it appears, that let yeast be ever so well kept from one brewing to another, its fermentative powers gradually decline, and that the obtainment of yeast from some other brewery is necessary, to restore fermentation to a vigorous and beneficial state.

A weak blistery head to a fermenting tun,
Proves that the process of brewing was not well done.

Various opinions are entertained, as to what is the particular cause of such an appearance, and but one I believe as to the general cause.

The particular cause, some attribute to the taking of too high mashing heats, and some to the taking of too low, whilst others who are doubtful to which it should be ascribed, express themselves by the dubious term, improper mashing heats.

The effect may be the result of various causes; but to whichever it may fairly and properly be attributed, the only safe course, in the absence of positive proof, is to guard against all possible causes, in order to avoid so injurious an effect.

Having scarcely ever experienced the effect, since I have been in possession of the rule to ascertain the proper mashing heats; I have happily not had the means of carefully observing the connecting circumstances, so as to be able by observation, to deduce the probable cause from the experienced effect: and as conjecture without proof is useless, I am induced to refrain from hazarding an opinion: but having for so many years almost totally avoided such an effect, I can but recommend to others, the same system of brewing, which has not subjected me to the frequency of its occurrence.

The scent of a fox to a sensitive brewer,
Is worse to his nose than the fumes from a sewer.

The technical term, "fox," given to a putrid infection of the utensils of a brewer, resulting from uncleanliness, or the use of putrid yeast, is well known among brewers; and is a disease or evil, much dreaded by them: and in sultry weather the greatest attention to cleanliness in every utensil, and in every department of the brewery, as well as the use of good yeast, is necessary to prevent the intrusion of so insidious an enemy.

Previous to the adoption of disinfecting remedies, by chemical means, nothing less than the total destruction of the infected vessel was necessary to expel the disorder from the premises; but the spread of chemical knowledge has led to the adoption of a less costly and inconvenient mode of extermination.

Lime is the general remedy adopted by brewers, which is slacked and applied as whitewash to the utensils affected; but the objections to lime are, the small disinfecting power it possesses, its incapability to penetrate the pores of the wood, and thereby reach the disease with which it may be more or less deeply impregnated, and the tenacity of its adhesion to the surface occasioning much difficulty to remove it.

Chloride of lime is recommended as better adapted for the purpose, but its great cost for a sufficient quantity is an objection.

The application of acids, is but the substitution of one disease for another.

A disinfecting fluid, of great effective power, and of small cost, I have found to be quite competent to eradicate completely the noxious visitant, as well as must, taint of every description, and acid; and is admirably adapted for the seasoning of utensils and casks formed of new wood, by an abstraction of its tanin, turpentine, &c.

If after racking comes on a foul fermentation,
The result often proves an acetous termination.

In the last stage of a brewer's labours, which consists in the racking, fining down, and sending out his beer for consumption, he too often finds his anxious desire to please his customers frustrated, by the commencement of a second fermentation, preventing it from becoming fine, and continuing until it passes from a vinous to an acetous fermentation; and in that state is either consumed with much dissatisfaction, or is returned upon his hands to become a baneful stock, and the communicator of future mischief. This evil more generally occurs in spring and summer, and the cause is to be traced to the various errors committed, from the first stage in brewing to the last.

The public taste in many counties, being completely changed from an approval of old dry store, to a love of new rich beer; and being both arbitrary and extremely fastidious, requiring throughout the year, without reference to time, seasons, or any circumstances whatever, beer brilliantly transparent, lightly hopped, perfectly mild, rich and full upon the palate, clean in flavor, abundant in carbonic acid, and retentive of all its good qualities to the last drop of consumption, in spite of all mischances, resulting from their own carelessness and mismanagement; it becomes no small difficulty, if not a case of impossibility, to cater for such exquisite consumers, and at all times to gratify such unreasonable and conflicting desires, in an unpropitious sesson, and under every adverse circumstance, let a brewer's knowledge and capabilities be ever so great: but as he must appear before such a stern and inexorable judge, the only chance he has to escape condign punishment, and confiscation of his trade, is to be proved a small and seldom sinning offender.

ADAPTATION, *the act of fitting and suiting.*

If every manufacturer was daily to think of the word adaptation, before he commenced the morning's operations, and was to reflect, whether the means he intended to employ, were adapted to accomplish his purpose, the commission of many a serious error would be prevented.

Reflection is the attendant of knowledge, the guide, the monitor, and the preceptor of the human mind. More real and advantageous business is often virtually done in a solitary walk, than is performed in the dizzying routine of multifarious avocations.

To plan and to contrive, to reflect and consider the adaptation, are mental operations that should precede manual performances.

He who neglects to consider, which is the best way to perform a work, to accomplish an object, to execute a project, and surmount a difficulty, until the moment he is required to be in a state of action; is surprised, flurried, unnerved, distracted, and altogether incompetent to the performance of the task, unless he possesses intuitive knowledge, commanding talent, and indurated nerves.

To-morrow's business should be thought of to-day. To-day the plan should be laid, the design drawn, the project weighed, digested, and adapted; and the morrow's performance will be plain, easy, and advantageously executed.

ADHESION, *the act of sticking or cleaving to.*

This is a term that requires consideration, as relates to the loss sustained in a brewery, by the adhesion of wort to the superfices of every utensil through which it passes, previous to its being sent out for consumption.

In breweries, as customarily fitted up, there are the one or more coppers, the mash tun, under back, wort pump, hop back, cooling backs, (probably a) refrigerator, fermenting tuns, cleansing casks, and store vats, through which the wort passes, previous to its being racked into the cask of consumption, and in its passage a loss is sustained by adhesion to each. If all these utensils are necessary, it is an inevitable loss, and therefore it is useless to regret it: but if part of these utensils can be advantageously dispensed with, their cost avoided, the expenditure on the building to contain them prevented, the loss of wort by adhesion to their surfaces rendered unnecessary, the labour to keep them clean got rid of, and the liability of their becoming infected by putridity avoided, the benefit resulting, will be proportionate to the number and the magnitude of those which may be dispensed with.

For single brewings one copper is quite sufficient, the under back and cooling backs may advantageously be dispensed with, and the fermenting tuns are not absolutely necessary, yet are they convenient.

In dispensing with the under back, the pumping up of nearly the whole of the wort may be avoided, consequently the resulting labour, loss of time and heat, and the additional exposure of the wort to the atmosphere. The loss of heat and the chemical injury sustained by wort, from its long exposure to the atmosphere therein, the loss of time and of wort by adhesion to its surface, and the labour of keeping it clean, liabilities of leakage, putridity, &c. may be all avoided.

In the building and fitting up a new brewery, to dispense with cooling backs, is to avoid, in many cases, the cost of the building that contains them, and the cost or loss of ground which they cover, in addition to the cost of the cooling backs; the chemical injury sustained by wort, by being too long exposed therein to an oxygenated atmosphere, the loss of wort by adhesion, which is equal to half a gallon to every barrel, of the strength of the last wort that covers them, at a depth of two and a half inches, the liability of loss by leakage, putridity, acidity, &c. the waste of water, and the labour of keeping them clean, and their occasional repairs, and cost of renewal when worn out: also the time, care, and inconvenience of watching the temperature of the wort, the difficulty in correctly judging of the probable loss of heat in running into the fermenting tun, the liability of getting it down too cold or too hot, the impossibility of reducing its temperature sufficiently low for pitching in hot weather, without a refrigerator, and the sitting up late and getting up early to industriously pursue a system pregnant with so many ills, which may be so easily avoided, with less cost, loss, labour, sacrifice of time and health.

The great saving in outlay of capital, fuel, labour, &c. by the use of one copper, instead of two or more, must be so obvious and plain to every reflecting mind, as to render an enumeration of the particulars unnecessary; but it is desirable that it should not only be generally known, that one copper is quite sufficient for single brewings in every brewery, but that such single copper is also able by proper management, to furnish a motive power in the form of steam, for every mechanical operation to which such a power is usually appropriated in the brewery, accompanied by a considerable reduction in the expenditure for fuel, which is usually required by the use of a separate boiler, for the purpose of imparting motion to the various machinery.

ADULTERATE, *to debase, corrupt, mix.*

To learn evil instead of good, is the natural bias of the human mind. Tell a person that you can inform him, how he can increase his profits, and the probability is, that he will imagine that your communication will furnish him with the mode to adulterate, to provide fair and specious appearances to inferior commodities, or to pursue some other system of dishonesty; and his cupidity being awakened, he will purchase with avidity any mysterious trash that you may offer him.

But if you offer him sound theoretical and practical knowledge, as the best and most suitable means to improve his manufacture or business, and advise him to pursue consistent, honorable, and honest measures, and to trust to the results of skill, care, attention, and judgment for an increase of profit; it is a great chance, but that he treats your proffered services with disdain and insult, instead of respect and courtesy.

Tell him of some drug to mix with the products of his manufacture, to give it a specious quality or appearance, and he will listen to you with complacency and pleasure; but tell him that his process of manufacture is chemical, that he needs a knowledge of chemistry, to enable him to conduct his several manipulations with skill, judgment, care, and economy; endeavour to point out the errors of his system, and the way to avoid them; the legitimate means by which he may improve the quality of his manufactured goods, and increase the products; and scorn and derision will probably be the reply to your overtures, and you will be called a schemer, a visionary, and an enthusiast.

AFFINITY, *disposition to unite, a mutual tendency to come together.*

The term affinity, is used to express in chemical language, that most important law or principle, which prompts two or more substances to unite together, and form a simple or chemical compound.

The union of the magnet with iron or steel, is the result of an affinity existing between each, which is the cause of the attraction that brought them together; and when together, they may aptly be termed a simple compound.

The union of the soluble materials of malt with water, is induced by affinity as the cause, and attraction as the agent; and a chemical compound is the result.

The magnet and steel may be separated, and their form and properties remain unchanged, but not so the wort.

It is true the water may be evaporated, condensed, and restored to its original state, but not so the extract.

Affinity may be termed the first and chief attribute of matter; an inherent principle appertaining to the atoms of which all substances are composed; and it may be called the love of atoms, prompting their union, and the consequent formation of substances.

Affinity precedes attraction, as the will does the action, it is its incentive and animus; and attraction is obedient to the impulse, causing the union of (what may be imagined) sexual atoms.

In the process of malting and brewing, affinity is the pre-eminent attribute, that causes the various organic changes that are effected, from the time of steeping the grain, to the consumption of the beer produced.

Affinity is the cause, that induces the penetration of the water to the centre of each grain in steep, operating as an inherent impulse on diverse species of atoms, of which both the grain and the water are composed; and attraction is the impelling power by which they are united.

Affinity is also the cause, that induces the penetration of air into the interior of grain in a state of germination, operating as an inherent impulse on the oxygen of the atmosphere and the carbon of the seed; and attraction is the impelling power by which they are united.

By the inherent desire, subsisting between atoms of diverse species to unite together, aided by the impelling power of attraction to effect their union, the decomposition and recomposition of all substances are effected.

AGENCY, *performance by a substitute, an acting medium between cause and effect.*

As the process of malting is laborious, and requires unremitting toil and attention by day and night, this most important branch of manufacture, is left to the performance of an agent, instead of being effected by the principal; and as an intelligent and well educated man, will not submit to such severe and irksome toil, and the rate of wages is too low to command talent, the operative part of the business is entrusted to an ignorant and strongly prejudiced labouring agent, whose knowledge of the business, is proportionate to the practical instructions which he has received; and being destitute of any theoretical acquirements, he works by an invariable system, let the occasions for variation be what they may.

To the maltster who makes malt for sale, gain by quality is generally of less consideration with him, than gain by quantity; and an ignorant labouring maltster, may serve his purpose perhaps as well or better, than one that is intelligent and well informed: but the brewing maltster who manufactures for his own use, and to whom the quality and quantity of wort obtainable from malt is of the greatest importance; the obtainment of an agent well skilled in the business, both theoretically and practically, is of great consideration: and it is a question of practicability and policy, whether or not the payment of high wages, might not command the practical services of an educated and intelligent person, by whose aid and instructions the malting process might be raised to its proper station, and lead to the developement and pursuance of a better system, that might very soon, more than compensate for the first sacrifice to procure it.

In too many instances also in the brewery, the most essential part of the business, the brewing, is left to the performance of an uneducated and uninformed person, whose only claim to a knowledge of the process is, a practical system, which whether suitable or not to the premises, to the trade, to the consumption, and to the required production by the customers, it is all the same; he knows no other, it is the one he was taught, and which he deems of all others the best, and if it does not happen to please, the cause lies with anything but him and his method; it used to do elsewhere and why not here, and if it does not, it is not his fault, it may be the water, or any other cause which he cannot discover, but he is sure it cannot be with him.

It is not of unfrequent occurrence, that when the principal is not himself acquainted with the process of brewing, or cannot or will not attend to it personally, but who is yet desirous of obtaining some one that is well skilled in it, and is disposed to be liberal as to salary, rightly judging, that its amount is of minor consideration, compared with the ability to brew good beer at the least cost; that he will engage some person who is celebrated for the production of beer which is in much repute; and anxious to realize all the advantages of a superior article, his pecuniary arrangements are made upon the most liberal scale, and proportionate to expected results; but his disappointment, mortification, and vexation, are not less extensive than the sacrifice; as he finds that the same person, can no longer produce the same article of equal quality; and why, neither one nor the other can tell; but perhaps and most likely they conclude, that a difference in the condition of the water, the state of the malt, the situation of premises, or some other undefined and unknown cause, prevents the realization of the same results upon his own, as was experienced in other premises, by the same brewer; not for one moment supposing that the true cause lies, in the non-possession of a sound and extensive theoretical knowledge of the process as a chemical operation, and a varied and extensive practical knowledge of the subject, combined with a well tried and established experience, resulting from long continued, close, and attentive observation, experimental enquiries, and varied practice in several establishments.

But that such is the fact, in almost all cases, where the same individual cannot produce the same effect in different premises, will admit but of little doubt, if the subject is closely investigated; for his very celebrity may be but accidental, having been fortuitously taught a practical system, well adapted for the peculiar premises in which he had to brew, but which may not be suitable for others; and his want of a sufficient theoretical knowledge of the business, incapacitates him from perceiving and making the necessary variations in his system, as are requisite to suitably adapt it, to the various differing circumstances which in other premises may militate against it.

To prove by demonstration that such may be the case, an allusion to a few prominent particulars, sufficient to cause all the difference in the results experienced, may serve the purpose.

A difference in the distance of the mash tun from the copper, the mode of conveying the mashing menstruum to it, and the circumstances of exposure to the atmosphere, during its transmission from one to the other, may be the cause of all the difference in the results experienced: for the brewer of the celebrated beverage, may have been in the habit of taking his mashing heats in the copper, at one fixed point, or subject to certain variations as induced by judgment or by guess, and the effect produced, may be an approximation to uniform results, or not so wide as to cause a serious difference in the quality or quantity of the wort: but remove him to other premises, and let him take the same heats, and the consequence may be, that the menstruum may reach the malt, at a very different temperature upon the premises in which he is newly placed, to what it did on those premises in which he formerly brewed, and such difference may alone be the cause of the production of that dissimilar effect, depriving him at once of his celebrity.

As illustrative of such a liability, it may be sufficient for me to state, that on the premises in which I first brewed, the usual loss of heat experienced in the transmission of the mashing menstruum from the copper to the mash tun, was four degrees; and on the second premises, the loss was eleven degrees; which was a sufficient difference to cause a serious discrepancy in the products, had I not varied my system to meet the circumstance.

In addition to this one cause may be named, a difference in the material and situation of the mash tun, the mode of mashing, the subsequent abstraction of heat during the time of mashing, and continuance of wort on the goods; the circumstances of exposure of the wort to the atmosphere in the under back, and the copper pan or back, and subsequent to boiling in the cooling backs; the want of a Refrigerator, the general temperature of the tun rooms, the size, situation, exposure, material, and principle of construction of the tuns; the general temperature of the cleansing rooms, size and form of cleansing casks, &c. &c. all which more or less may contribute as causes, to the production of a very different beer upon premises to which he has been accustomed, provided he attempts to confine himself to the same system in one as in the other: and hence the advantage, that both principal and agent, should possess a competent theoretical, as well as practical knowledge of the business, so as not only to be able to make the necessary variations in the system of brewing in the same premises, but also to be able to adapt it to any other, in which they may ever have occasion to brew.

AIR, *the element in which we breathe, the fluid that surrounds the earth.*

To furnish all the interesting and instructive details relative to air, is not the purport of this work; but merely so much as is connected with the process of malting and brewing.

The atmosphere which surrounds the earth, is a compound of pure air, and a variety of gases and vapours.

Pure air is a chemical compound consisting of about twenty parts of oxygen, and eighty parts of nitrogen, with a very small portion of carbon, and a large quantity of latent and free caloric.

The atmosphere may be termed a simple compound, or admixture of air, gases, vapours, &c. which do not unite with it in that close and intimate connexion, so as to form a new compound; but exist together in a mixed, yet separate and divisible state.

Considering the atmosphere then as a simple compound, its purity is but relative, and proportionate to the presence or absence of those vapours, gases, &c. which are injurious to health, vegetation, germination, and the process of manufacture of various substances; and the state of the atmosphere, which may be beneficial to one portion of the multifarious operations of nature and of art, may be prejudicial to another.

In the state and condition of the atmosphere, both maltster and brewer are deeply interested.

Air is to them a subject of great importance, as relates to the constituent principles of which it is composed, as well as the heat by which it is rendered ærial.

The atmosphere is also to them a subject of still greater importance, inasmuch as it not only includes all in which they are interested as relates to air in a separate state, but also to the gases and vapours which are mixed with it.

Oxygen and heat derived from the atmosphere, are the principles with which both maltsters and brewers have most to do, and which affect their operations to a beneficial or prejudicial extent, proportionate to their advantageous or injurious presence.

Without heat and oxygen, neither the process of malting or brewing can be conducted; the presence of both in the atmosphere to a certain extent, is advantageous as relates to each process; and the presence of too much of either or both is injurious; and experience proves, that the presence of a medium quantity of both in the atmosphere, renders it the most suitable, as an agent of communication of the requisite quantity.

The quantity of heat and oxygen in the atmosphere naturally present at different periods of the year, is the true criterion, that constitutes and marks the proper and most favourable season for conducting each process; and common observation and experience, has assigned that portion of the year commencing in October and ending in March, as the best season for either process.

If either a maltster or brewer, is under the necessity of carrying on the process of malting or brewing, at an unseasonable period of the year, it should be his business to adapt his system of conducting either, so as to avoid as much as possible, the injurious effects resulting from the presence of too much heat and oxygen in the atmosphere.

The absorption of oxygen from the atmosphere by grain in a state of germination, is necessary, in order to abstract a superfluous quantity of carbon which it possesses, as relates to its requisite properties as malt; and also by the impartation of oxygen, to convert a portion of the fecula into saccharum: and the impartation of heat is necessary to facilitate the abstraction of carbon, and the combination of oxygen.

The combination of oxygen derived from the atmosphere, with the carbon of the wort, previous to, and during the process of fermentation, is necessary for the abstraction of a superfluous quantity of carbon which it possesses, as relates to the requisite properties of beer; and the retention of a portion is indispensable to the creation of spirit, and the impartation of heat is necessary, as an agent to effect both.

The combination of oxygen with carbon, creates carbonic acid, which could not be abstracted from either grain or wort, without the aid of heat; and the impartation of heat renders it ærial, in which state it is called carbonic acid gas.

The atmosphere is to the maltster and brewer a mechanical agent also: the maltster resorts to its use, by its admission into his malthouse, for the purpose of abstracting the superfluous heat of the room and the grain, and to sweep off the carbonic acid gas, which has been ejected from it in the process of germination; and to effect such purposes to the requisite extent, and not beyond, demands the best judgment of the maltster.

It is also used as a chemical agent, to cause and promote the combustion of the fuel, which is used to dry the grain on the kiln; and also to impart oxygen to the grain, for the purpose of converting an additional quantity of fecula into saccharum, and to furnish the required color and flavor; and as a mechanical agent, to carry off the vapour which is emitted from it; which is effected by a current of air passing over the fire, and through a draught aperture on each side of the furnace, in many malt kilns; and which being thereby heated and dried, ascends and passes through the perforated kiln floor, and carries off the vapour in its rapid ascent by the cowel.

As a mechanical agent, both the maltster and brewer experience its utility, in the obtainment of water by the aid of a pump.

The action of the atmosphere as an agent, in raising water from wells of various depths, is by pressure on the surface of the water, compelling it to rise up (what is called) the suction pipe of the pump.

The pressure of a column of air one foot square, upon the surface of the water, is equal to the weight of 2160 pounds, or one inch square, 15 pounds; and which pressure is equal to the raising and supporting a column of water in the suction pipe, 34 feet high.

When a pump is first put into a well, the suction pipe is full of air. The action of the pump, is first to withdraw the air from the suction pipe, and which being removed, the water supplies its place, being impelled thereto by the pressure of the atmosphere upon the surface of the water in the well, until it has attained to the height of about 34 feet. [For further information see article "Pump."]

The atmosphere is also used as a mechanical agent by many brewers, for the purpose of reducing the temperature of wort from the boiling point, to the required heat to which it should be got into the fermenting tun.

The atmosphere is also the chemical agent for the impartation of oxygen to wort, previous to the commencement and during the continuance of fermentation; and the mechanical agent for the reception of the carbonic acid gas and heat, which is evolved from wort during the process of fermentation.

ALCOHOL, *spirit.*

The chief characteristic of vinous fermentation, is the production of spirit.

Wort subject to a vinous fermentation, is productive of spirit, in the ratio of one gallon of proof spirit, for every five pounds reduction of density of the wort by vinous fermentation.

To render this statement more intelligible, let us suppose that wort of 30 pounds density per barrel, is submitted to vinous fermentation; and that on the termination of such fermentation, its density is 10 pounds per barrel; it will be said then, in technical language, to be attenuated 20 pounds, or attenuated to 10 pounds: the result of such fermentation, or attenuation is, that such fluid which in the state of wort, possessed not one particle of spirit, now possesses it in the ratio of four gallons of proof spirit, in one barrel of fermented wort, being in the proportion of one gallon of proof spirit, for every five pounds density of the attenuation experienced.

The inebriating principle in vinous fermented fluids, is spirit.

The stomach may be compared to a still, and its heat is sufficient to separate the spirit which a vinous fermented fluid contains, by distillation; and the alcoholic vapour acts as a narcotic on the brain.

The stomach may also be compared to a fermenting tun; and its heat is sufficient, and more than sufficient, to cause a decomposition of a vinous fermented fluid by fermentation; and the gaseous products act also as a narcotic on the brain.

The production of spirit, is not only the result of the first process of vinous fermentation, such as occurs in the fermenting tun and cleansing cask; but also of the second, or what is termed the insensible fermentation, which occurs in the vat or store cask, and which is produced in the same ratio as to quantity, as is effected in the first process. Hence the basis of the common observation, that beer, &c. increases in strength by age; for as by insensible fermentation, attenuation still continues to go on, until it has reached the maximum of capability; and as by insensible fermentation, (as it is termed) the process is slow, the additional production of spirit is proportionate in speed, to the promptitude and regularity of such fermentation, and proportionate in quantity to the amount of attenuation. Thus if the wort whose original density was 30 pounds per barrel, is first attenuated to 10 pounds per barrel, by the first process of fermentation; and has by such means acquired spirit, in the ratio of four gallons at proof per barrel; and is subsequently attenuated to two and a half pounds per barrel, by insensible fermentation; it will then possess five and a half gallons of proof spirit per barrel.

But this assumption of the quantity of spirit possessed by beer, attenuated to two and a half pounds density per barrel, or any other point, is founded on the supposition that an acetous fermentation in conjunction with the vinous has not occurred; for if it has, a less quantity of spirit will be possessed proportionate to the extent of the acetous fermentation.

A vinous fermentation may be conducted to the lowest attainable point of attenuation, unaccompanied by an acetous fermentation; and consequently the vinous fluid may possess the full measure of spirit; but as soon as that spirit is reached, an acetous fermentation will commence, and the quantity of spirit will gradually decrease, in ratio, proportionate to the celerity and extent of the acetous fermentation.

Thus the prevention of a vino-acetous, or an acetous fermentation, is of the highest importance, both as relates to the presence of an objectionable quantum of acid, and a deficiency in the full measure of spirit.

ALE, *a liquor made from malt and hops by infusion, &c. in water, and by vinous fermentation.*

Beer in the general acceptation of the term, denotes the whole of the products of malt and hops ; but several names are used to distinguish the peculiarities of the products, as relates to strength, flavor, and color; such as ale, table beer, double and single stout, porter, &c.

The distinguishing characteristics of ale are, that it is stronger than table beer, and paler in color, and of less flavor than porter.

To say what are the properties, that designate the best ale, would be to express an opinion, that would not meet with universal concurrence; but it may be within the limits of probability, to state successfully what is the general opinion: pale or amber in color, full in the mouth and clean on the palate, lively in taste, transparent and sparkling in the glass, perfectly sound yet acidulously sweet, and of pure flavor, are the technical terms which it is presumed are sufficiently expressive to denote the qualities of the best ale.

ALEGAR, *sour ale, or beer vinegar.*

Vinegar is a term of general import, as applied to acetous acid, the products of any vegetable fermentative substance; but the term alegar is used to denote such as is the product of beer only.

The distinguishing difference between alegar and malt vinegar is, that the latter is commonly brewed without hops, and is fermented for the ultimate purpose of being used as vinegar; whereas alegar is the unfortunate result of an improper mode or time of brewing, or the unfavourable preservation of that which was designed for consumption as beer.

The infusion of hops in malt wort, and the extract obtained therefrom, presents a great impediment to an acetous fermentation, because such extract furnishes a large quantity of carbon, between which and the oxygen of the atmosphere, there is a strong affinity, which operates to induce the combination of the two, and consequently cause the formation of carbonic acid.

Under favourable circumstances, the combination of the oxygen of the air, with the carbon of the wort, will be slow and gradual; and while any portion of carbon remains in the wort, carbonic acid will continue to be formed, and acetous acid will not be created ; but as soon as the whole of the carbon is exhausted, then the formation of acetous acid will commence. But long previous to the exhaustion of the stock of carbon, the formation of acetous acid may commence, if under adverse circumstances the absorption of oxygen from the atmosphere, is more rapid than its combination with the carbon can occur. To this last named circumstance and cause, may be attributed the conversion of beer into alegar.

Alegar may be found in almost every brewery, of different degrees of acidity, and is ever a baneful stock to a brewer, except such small portion as he needs for the solution of isinglass for the formation of finings.

Some brewers who possess but an insufficient knowledge of their business, imagine that an admixture of stale with new beer, is equivalent to the supply of sound old beer, supposing that the presence of too much acid in the one, and the presence of none in the other, will furnish a blended compound, possessing an equal quantity of acid with sound old store beer, and therefore calculated to yield equal satisfaction to the consumer.

But such an idea is altogether erroneous, as relates to the quantity of spirit contained in such an admixture, and as relates to the flavor of the compound; for the stale beer, whatever may have been the extent of its attenuation, and the quantity of spirit it possessed previous to its acetification; yet in proportion to the extent of that acetification, so must have been the diminution of such spirit; and it is more than probable that the new beer, has not been attenuated to its full extent, and consequently cannot possess its full measure of spirit; while on the contrary, a sound old store beer may have been attenuated to the extent of its capability, and be in the possession of all the spirit which may have been created: and as relates to flavor, the mere admixture of stale and new beer, forms but a simple and not a chemical compound, and presents to the palate of the consumer a double flavor, a sour and a sweet, discernably distinctive to the taste.

A stock of stale beer is generally the result of either the possession of an insufficient knowledge of the process of brewing, unsuitable premises to brew in, improperly or inadequately fitted up, a want of sufficient care and caution in the brewery, the bad management of publicans and other consumers, unavoidable circumstances, the adoption of imprudent and untimely measures to diminish the amount, causing the reverse of the desired effect, in an increase, &c. but to whatever cause such an effect may be attributed, prudence dictates the adoption of a better, or a more careful system, in order to avoid a recurrence of the evil; and suitable measures to remove such as has been already incurred.

It has been already stated, that at every period of the year, wort which is exposed to the atmosphere, is capable of absorbing as much oxygen from it, as is sufficient to cause the commencement and continuation of the process of vinous fermentation; and that in the spring and summer months, it is liable to the absorption of too large a portion, without the adoption of vigilant precaution, a correct system, and prompt and rapid measures; and that the result of too great an absorption, is a vino-acetous fermentation; and that such a fermentation is not productive of a full measure of spirit; hence it must be plain and obvious, that as the acidity of alegar, is attributable to the presence of too much oxygen, so the addition of stale beer to wort previous to fermentation, is but the impartation of a surplus quantity of oxygen; and whether it is effected in autumn and winter, or in spring and summer, it is in either case injurious, but more particularly so in the latter seasons.

The addition of stale beer to new beer on the termination of the first stage of fermentation, and previous to, and after the commencement of the second stage, is fraught with danger, and the injurious results are ever apparent; inasmuch as beer which has passed through the first stage, is at every period of the year, capable of absorbing a sufficient quantity of oxygen from the atmosphere, to carry it through the second stage, to the lowest point of attenuation, and the creation of a full measure of spirit; and the danger and difficulty is, to prevent too great an absorption, and the consequent insufficient production, or subsequent diminution of spirit; and it does not need the impartation of a superfluous quantity of oxygen, to produce either of those effects by the medium of stale beer.

It is quite necessary that the brewer should also know, that the impartation of stale beer to wort, either previous to, or during the first or second stage of fermentation, is productive of an evil, the magnitude of which, is not to be computed by the quantity of oxygen which is contained in the beer which is added, but by the derangement which it effects in the several combinations of atoms, causing insufficient production or diminution of spirit, and an increase of acetous acid, in a ratio far exceeding the amount added.

The process of fermentation is the simultaneous decomposition and recomposition of the substance operated upon; and is effected by the impartation and abstraction of atoms to and from the substance; and the resulting product, is conformable to the number and species of atoms imparted and abstracted, and the priority and order of the mode of impartation and abstraction; and therefore to cause a substance to pass into the vinous, vino-acetous, acetous, or putrefactive process of fermentation, it is necessary to administer to such substance, or place it under such circumstances, as may enable it naturally to receive such atoms by impartation, and to part with such atoms by abstraction, as are necessary to produce the required effect: thus in vinous fermentation, the purport is to impart the oxygen of the atmosphere to the carbon of the wort, in order to abstract such carbon to a definite extent, in the form of carbonic acid gas; and also to impart oxygen, to combine with a definite portion of the carbon and hydrogen of the wort, for the formation of spirit; and as the impartation of the oxygen, the abstraction of the carbonic acid gas, and the formation of spirit are simultaneous operations; and as it is requisite that they should be conducted in order and regularity, with due precision, and in harmonious concert; so it is necessary that the impartation of oxygen should be in the exact ratio as to quantity and rapidity, to the amount required to effect the combinations in the order prescribed; and the circumstances favourable to the fulfilment of the several conditions, which are necessary to effect an advantageous vinous fermentation, are the presence of a moderate quantity of oxygen in the atmosphere, in a state of simple mixture; a medium atmospheric temperature, a properly compounded wort to operate upon, a correct pitching heat, a right quantity of good yeast, the absorption of a proper quantity of oxygen by the wort, previous to, and during the progress of fermentation, and a sufficient and free evolation of the carbonic acid gas; and it must therefore be plain and obvious, that as when the atmosphere is charged with the least quantity of oxygen, it possesses a sufficient amount to cause the commencement and progress of vinous fermentation, by a slow and gradual impartation; so the impartation of any by the medium of stale beer, must inevitably cause a vino-acetous fermentation; and which by a subsequent absorption of too much oxygen from the atmosphere, may pass into an acetous fermentation.

From these preliminary observations it will appear that stale beer possesses less spirit than sound beer, and therefore its quality is impaired, by the production of an insufficient quantity of spirit, as the result of a vino-acetous fermentation; or a subsequent diminution of the spirit which may have been created, as the result of an acetous fermentation succeeding the vinous; and also from the presence of more acid, than may suit the palates of the consumers; and hence the necessity or advantage of obtaining that knowledge, which is requisite to enable the pursuance of those salutary measures, and the adoption of those precautionary means, which are sufficient to prevent the accumulation of such a stock.

But from whatever circumstances a stock of stale beer may be created, no remedial measures will restore that spirit which has been lost, nor can an equal quantity be advantageously replaced: but the acid may be removed by chemical ingredients at a cost of about seven-pence per barrel, without the impartation of any ill flavor; but on the contrary that ill flavor which results from the acetification of beer, will be removed with the acid, and such beer may then be blended with new beer in right proportions, and in a suitable way, so as to be advantageously disposed of.

ALKALI, *the contrary of an acid, a salt, &c.*

Alkalies are the production of a variety of plants and vegetable substances, also of animal substances, minerals, &c.

Alkaline substances are distinguished by their properties, or capability of combining with an acid substance, so as to neutralize the acid and alkaline properties of each, by a combination of the oxygen of the acid, with the carbon or hydrogen of the alkali; and the result is the decomposition of the two substances, and the composition of another from their products, characterized by new properties.

Some substances classed among the alkalies, such as potash, soda, and lythia, consist of a metallic base combined with oxygen; others there are, which contain no oxygen, such as ammonia, &c. and again there are some which possess a metallic base, but are composed of oxygen, hydrogen, and carbon.

The presence of oxygen in an alkaline substance, is no barrier to the combination of its carbon and hydrogen with the oxygen contained in an acid, and to the formation of a new compound; but it is a question, whether those alkaline substances possessing oxygen, are the most suitable and economical for the neutralizing of an acid.

But the neutralization of an acid is not sufficient for the brewer's purpose, inasmuch as the oxygen being retained in the beer, although in a different state of combination, it is liable to be restored to its former associations, and again become a component portion of acid, by a subsequent chemical decomposition of the new formed compound; and therefore nothing less than the absolute separation and removal of the oxygen, forming a constituent of the acetous acid from the beer, is sufficient to render such beer fit for an admixture with new beer.

To effectually remove such oxygen, it is then necessary to add to the beer, such substances as contain a large amount of carbon, and in the decomposition of which, a great quantity of heat is converted from a state of latency, into a state of activity; and such carbon and heat combining with the oxygen of the beer, the result of their union is the formation of carbonic acid gas, and which evolating from the beer, carries off the oxygen, instead of merely combining with it, and both becoming residents in the beer, as in the case of neutralization only.

The ingredients which I recommend for the removal of the acid of stale beer, possess those requisite properties, as well as absorbent properties, for that rancid oil which stale beer possesses, and which impart to it a peculiar ill flavor; and the effect which their use produces, is the formation of a very large volume of carbonic acid gas, which is separated from the beer by evolation, and the absorption of the rancid oil, thereby removing the acid and improving the flavor of the beer.

ALTERNATIVE, ***a choice of one of two things.***

When two or more things or methods are offered to a free choice, the judgment should decide which is the most advantageous, prudent, and proper to accept.

Thus when the means of obtaining profitable knowledge, is offered at a given cost, it may be necessary or desirable, previous to the determination, whether the offer should be accepted or rejected, first to examine, whether or not the information proffered is delusive, or whether it is valuable; what is the amount of its value, and if there is a fair prospect of realizing the advantages held out; and if they are more than commensurate to the cost.

An indolent indisposition to make these necessary enquiries too often leads to the purchase of that which is nothing worth, and to the rejection of that which is truly valuable.

The purchase of a promised benefit, which proves to be mere trash, converts credulity into suspicion; and with the determination to avoid the risk of a similar imposition, the avenues of the mind, are carefully guarded against the access of good as well as evil.

Offer valuable information, and many will turn a deaf ear to all that is said, and cut short the communication by the observation, " I have been deceived so often, that I will listen no more to any one." And why have they been deceived so often? May it not be, because they have not submitted the thing offered, to the test of a scrutinizing judgment, either from indolence, or the want of that general knowledge, which enables a person to prove the value of that which is offered, by the test of reason?

And does it follow, that because the uninformed mind has a disposition to buy quackery, and finds that the anticipated cure of the evil is not effected thereby, that there is no salutary knowledge to be derived from any one?

And is there no alternative, but the rejection of all proffered information, lest the whole should be evil, or that evil should be mixed up with the good?

The real cause of that strong predilection in the minds of many, in favor of whatever is ambiguous, mysterious, and wonderful, is an ignorance of the elementary principles of science; and thus those who desire to gain regardless of the means, have ever something to offer to the credulous, which may proffer an apparent advantage to a superficial observer; but which will not bear the close investigation, of one who never fails to submit all ambiguous propositions to mental analysis, previous to a determination of their value.

AMENDMENT, ***a change for the better, a correction.***

If any manufacturer can say of his premises, or his system of manufacture, or mode of conducting business, that there is no need of the amendment of either; he must either be very ignorant of those defects which are apparent to others, or he must have pushed improvement far beyond the conception of his compeers.

If the point is conceded, that the best arranged and situated premises, and such as are fitted up on the most suitable principles, are in the management of the best informed, skilful, and experienced person, and every department of business conducted by intelligent men, yet altogether it presents a very imperfect compendium; surely the most rigid enquiries are due to the interests of the proprietors, as to what amendments can be made, that promise to yield advantages, more than equal to the cost or sacrifice attendant on the correction or improvement of those defects which are found to exist.

It should be the enquiry of every manufacturer, or person engaged in business, if his premises are well situated, built, arranged, and contrived; if they are sufficiently large, or too capacious, for the advantageous manufacture of the peculiar products of his trade; and if they are fitted up on correct and profitable principles; and in case they are not, his attention should next be turned to the capability of their amendment, the cost, and the apparent benefits that may result therefrom.

Having revised the mechanical department of the manufactory, the accustomed process of manufacture should next be strictly investigated, its defects discovered, its evils corrected, and improvements introduced into every branch of the business if needed.

ANALOGY, *a resemblance, relation, proportion, &c.*

The analogy subsisting between the operations of nature and art, and between the process of one manufacturer and another, renders a correct and extensive knowledge, truly desirable and advantageous.

A strong analogy exists between the process of germination as it occurs in the earth, and in the malthouse.

The first for the sake of distinction, may be said to be the work of nature, and the latter the work of man.

The maltster should thoroughly understand the modus operandi of nature, in carrying on the process of germination in the field, in order that he may learn to adjust his process in the malthouse, as near as circumstances will admit, to a resemblance of her perfect work; and it should ever be borne in mind, that all the products of art, are but the imperfect imitations by the created, of the perfect performances of the Creator.

The maltster should be able to comprehend the internal structure of the grain, its component substances, their ultimate principles, and the relative proportion of each species. He should be well versed in the laws of affinity, simple attraction, attraction of aggregation, and of cohesion. He should well understand the laws of equalization to which heat is subject, the expansion of bodies resulting from the impartation of heat, and the contraction of bodies from the abstraction of heat; and should know the distinguishing characteristics of latent and active heat. He should be well informed in the theory of the decomposition and recomposition of bodies, both partial and total. He should learn the composition of soils, and endeavour to discover the cause of the favorable, or unfavourable growth of grain therein. He should try to discern, if the solution of any portion of the component materials of the soil in which grain is deposited, is effected by the rain which falls upon it; and if the grain which imbibes it in solution with the water, germinates the more favorably in consequence; and if so, whether or not he can profitably make the addition of a similar material to his steep water. He should be acquainted with the usual, and best adapted temperature of the soil in which the grain is imbedded, to cause and promote germination, and from such information he may derive the proper temperature at which should be his steep water, and his malthouse working floors, and by the aid of mechanical resources, he should then adjust both to the right amount. He should comprehend the difference between germination and vegetation, and the terminating point of the one, and the commencement of the other: also the adventitious nutriment supplied by water and air, and the internal supply contained in the grain, to assist in the commencement and continuation of the growth of the root and acrospire; and from such an investigation he may learn, that as the external supply of nutriment should be ample, yet not more than sufficient to prevent the premature exhaustion of the internal supply, so should he by art provide in the malthouse, such nutritious principles as are needed, and in right condition and proportion, to carry on the process of germination to a proper extent, without an unnecessary consumption of the store of nutriment, contained within the body of each seed, the waste and loss of which is a substraction from the quality of the malt.

In addition to that knowledge which the maltster should possess, the brewer may obtain much valuable information from the analagous operations of nature in decomposition, solution, combustion, and fermentation; nor will he fail to derive benefit from a careful and attentive study of the operations of the distiller, the rectifier, the wine maker, the vinegar manufacturer, the baker, &c.

ANALYSIS, *a separation of parts, a decomposition of a substance, and division of its component substances or ultimate principles.*

That the arts, sciences, manufactures, and commerce, are deeply indebted to eminent chemists, for the analysis of a variety of substances, is an indisputable truth; and that their improvement yet further, would be promoted and accelerated, by an extension of such labours in this most important and useful department, is no less obvious than true.

The inestimable services which have already been rendered to the community, by the analysis of the air we breathe, the water we drink, the food we eat, and the earth on which we tread, are but a small portion of the aggregate amount of benefits which have been conferred, and which demand the grateful recognition of every recipient: and while we acknowledge the debt of obligation, we cannot but feel regret that a very great number of substances, have either not been the subjects of analysis, or the results are not on record, or not accessible to, by manufacturers who are deeply interested in all that relates to their properties and their component principles.

Engaged in the all absorbing pursuits of practical business, the manufacturer has but little or no time to turn his attention to theoretical enquiries; and however strongly desirous he may be to improve his own process, his ardour in search of that knowledge, which is necessary to reflect light upon, and to unfold the properties, and make known the ultimate principles and their proportions, &c. of the substances that are subject to the operations of his peculiar manufacture, is damped and discouraged in the outset, because he is conscious of his need of the elementary knowledge which must be obtained, previous to the attainment of the capability of effecting an analysis.

Having ascertained his want of knowledge, he scans the extensive field, in which is hid the treasure of which he is in pursuit, without beacon or land mark to denote the spot in which it lies. "Dig deep and miss it not," is the only response to his enquiries. To begin and continue until it is obtained, may require a life of labour, and shrinking from such an Herculean task, he contents himself with the quiet tenor of the ancient way, and makes no contribution to the improvement of the age.

Such may be said to be the general state and condition of many manufacturers, the nature of whose avocations entitle them to the designation of peculiar practical chemists; and who are taught to perform a chemical operation, without any tuition, or knowledge of the elementary principles of chemistry.

The transmission of a practical process from one generation to another, may occur without improvement; because the knowledge of each practitioner, does not extend beyond the precincts of the precise method of the original discoverer.

Both maltsters and brewers are practical chemists, in the proper acceptation of the term; yet what do they (generally) know of chemistry? So little indeed, that it would be no trifling task to convince them, that the process of either malting or brewing is chemical. And if such is the fact, and the point is conceded, can it be wondered, that so little improvement has as yet been made in either department; and that in the only quarter in which search can be effectually made, for real and substantial information, that is calculated to accomplish it, an enquiry is scarcely ever made.

The man who devotes his time and attention to the study of chemistry, merely as a scientific pursuit, may for the sake of distinction be called a theoretical chemist: and the person who performs chemical operations as a matter of business, may be termed a practical chemist.

One of the former class has furnished us with the following results of an analysis of barley and malt.

Gum	5 parts	14
Sugar	4 "	16
Gluten	3 "	1
Starch	88 "	69
	100 barley.	100 malt.

But it is the maltster (the practical chemist) who effected the chemical operation, in transmuting the barley into malt. And what did he perform by the process? It appears by the statement that he effected a considerable increase of the gum and sugar, and diminution of the gluten and starch. And how did he accomplish it? The recorded process of malting informs us, that he steeped the grain in water several hours, and at the expiration of a suitable period, he withdrew the water, and removed the grain from the cistern to the couch. That he let it remain an allotted time, and then spread it thinner on the floor. That he continued to rake and turn it several days, until he deemed it in a fit state to be thrown on the kiln, which was done, was thereon dried, received flavor and colour, and was finally removed to the malt store.

But will this meagre representation of the labours of the maltster, (the practical chemist) satisfy the scientific theoretical chemist? Certainly not! He has analysed the product of the maltster's operation, and finds an increase of gum and sugar, and a diminution of gluten and starch, and has been told what measures were taken to accomplish it; but he discerns, that to him, a hidden and mysterious operation has been performed, productive of an unaccountable effect: he finds that by the apparent addition of water alone, which possesses neither gum nor sugar in a state of solution, that an increase of both has occurred: and he finds that a diminution of the gluten and the starch, which appears to have been effected by the steep water, is not contained in that water as its analysis has proved, but which on a superficial view of the subject, it might naturally be supposed, it had dissolved and abstracted. Then what can be the cause? Reflection suggests, that analysis should yet be carried a step further, and that the clue to the mystery may thereby be discovered. It is done! each of the substances are reduced and subdivided into the ultimate principles of which they are composed, and the result of the operation is exhibited by the following statement:

	Gum.	Sugar.	Gluten.	Starch.
Carbon	41,936	37.290	55,700	43,481
Oxygen	6,452	55,870	22,000	48,455
Hydrogen	51,612	6,840	7,800	8,064
Nitrogen			14,500	
	100,000	100,000	100,000	100,000

Having ascertained by this subdivision, what are the ultimate principles of which barley is composed, and the relative proportion of each; the previous knowledge which he has obtained of the properties of those principles, and the laws to which they are subject, enables him to unravel the mystery and account for the increase of gum and sugar, and the diminution of the gluten and starch. He now clearly sees, that the distension of the body of the grain, by the absorption of water, is a preliminary mechanical operation, which renders its state and condition more appropriate for the chemical operation, to which it is about to be subjected.

He is fully aware of the affinity which exists, between the ultimate principles of the grain and of the water imbibed, and the law of attraction to which they are subject; the combination of atoms that must occur, the decomposition of the original substances that must commence, and the composition of new substances, which must be the resulting consequence, or the accretion of atoms to the original substances, or the abstraction therefrom.

He knows also, that a large quantity of oxygen is in the atmosphere in a state of simple mixture, free to combine with the carbon of the grain, and by such combination to form carbonic acid; and he is aware to, that by such combination latent heat is rendered active, and that such heat in unison with carbonic acid, converts it into carbonic acid gas; and that in the state of gas at a higher temperature than the atmosphere, its specific gravity is less than such medium, and in which it consequently rises. And the result of the enquiry convinces him, that the increase and decrease of the substances mentioned, arises from the interchangeable transition of atoms, between the body of the grain and the water imbibed; and subsequently and simultaneously between the atoms of the body of the grain, and the surrounding atmosphere, induced by the power of affinity and attraction.

Thus the theoretical chemist while sitting in his study, discovers and developes the arcanum of the process; while the practical chemist, (the maltster) fulfils all the mechanical conditions of the operation, without a knowledge of the theory. And here the reader may be inclined to ask the question—and what is the utility of knowing the theory of the process? To which the reply is; that as there is a purpose in expending so much time, labour, and money, in the conversion of barley into malt; and that purpose is the increase of its gum and sugar, and the diminution of its gluten and starch; so the possession of that theoretical, as well as practical knowledge, as is sufficient to enable the maltster to effect the greatest increase and decrease in the several substances as is required, must be highly useful and advantageous to the possessor; and it is much to be regretted, that the maltster has not sought or obtained, the assistance of the theoretical chemist, to enable him to realize the most profitable result of his labours.

The paucity of information extant relative to the theory of malting, is mainly to be attributed, to the apathetic indifference both of maltsters and brewers to the subject; and it cannot be expected that learned and intelligent men, will devote their time, energies, and pecuniary resources, to benefit those, who neither deserve their gratuitous services, or would compensate them with fame or wealth, as a just reward for the information rendered.

When we enquire as to the attainments of these practical chemists, (the working maltsters) we find that but a few can either read or write; and the wonder is, that they possess so much knowledge of the subject as they do, rather than that they do not possess more. But it will be found that the portion they do possess, varies to a considerable and most important extent; and that the employer who is sufficiently fortunate to meet with one that is superior to his fellows, enjoys a superlative advantage, which he can perhaps scarcely appreciate the value of: and if there are different degrees (and extensive ones too) in the capabilities of the working maltster to make good malt, the very circumstance of their being that difference, is a most powerful argument, in favor of the obtainment of that assistance, which theoretical chemists are the best adapted to furnish.

And what is the cause of the great difference between the capabilities of one maltster and another, to make malt of good quality? It is this! A working maltster receives little or no mental education, independant of, or relative to his avocation. He is the pupil or assistant of an experienced practical man, whose whole experience consists in knowing, or supposing that he knows, when and how to perform the mechanical routine of labour connected with the subject.

The only indicators to point out the right time for, and the mode and extent of each performance, are the eyes and the judgment. The eyes have been accustomed to notice certain appearances, followed by peculiar practical effects; the mind to record the circumstances; and the judgment to note the value of them; and this system of self tuition is pursued, until the faculties of perception, have become accustomed and habituated to appreciate promptly, the state and condition of the grain under operation; and to determine with facility, the operative measures which should be adopted; and this power of discernment and decision, is called practical experience. But it can require no laboured argument to show, that such an appearance of the state and condition of malt on the working floor, as would be imperceptible to a casual observer; may also assume a very great difference in appearance, to the more practised sight of different maltsters; and that if each was required to give an opinion, as to what measures of operation should be adopted with such grain, it is more than probable, that a variety of opinions would be offered.

Instead of being taught to make good malt, the novice is but allowed to learn if he chooses, and happens to have for his exemplar, a person who is well versed in the practical department of the business. He has to learn to imitate the performances of his exemplar, without being informed of the motive for the action; and as a parrot learns to talk, so he must learn to work, without comprehending the meaning of his doing. If his so termed teacher practises well, and he has sufficient capacity and inclination, to note and observe the several appearances, as relates to the state and condition of the grain previous to, and during the process of germination; and to take notice of, and remember, the peculiar operations performed, or directed by his (comparatively) automaton exemplar, upon each peculiar occasion; he may then have a chance, in the course of a long continued practice, to equal the original, but none to surpass it.

The ill effects resulting from this mere mechanical mode of learning how to manufacture malt, is abundantly evident, when one of these so taught maltsters, is required to make wheat malt; for being entirely unacquainted with the theory of malting, and experienced only in the practice of making barley malt, he is quite unconscious of the necessary variation which should be made in his system, and pursuing the same method in the malting of both, he consequently fails to produce wheat malt of good quality.

The following comparative analysis of barley, and unripe and ripe wheat, will afford a convincing proof, that a different system of malting, to produce the same results in each, or an approximation thereto, must be pursued; and that the theoretical chemist, from his knowledge of the component principles of each, and the laws of affinity and attraction, which hold them in combination; is far better able, to correctly direct the labours of the maltster, than he can be to act on his own unassisted judgment.

Barley.		Unripe Wheat.		Ripe Wheat.	
Gum......	5	Gluten....	24	Gluten....	19
Sugar	4	Starch.....	70	Starch....	77
Gluten	3	Not stated	6	Not stated	4
Starch	88	....		....	
	100		100		100

By reference to the statement of the analysis of barley and barley malt, we find that in the process of malting, that the quantity of gum and sugar is increased, and the gluten and starch decreased; and by reference to the above statement we find, that the gluten which ever forms a component of malt in superfluous abundance, is more predominant in unripe wheat, than in that which is ripe; and that consequently the ripening process, confers the benefit of a diminution of the gluten, and an increase in the quantity of the starch; and it will also be perceived, that the ripe barley possesses a much smaller quantity of gluten, and a larger quantity of starch than the ripe wheat; and consequently that the extent of the transformation of the component substances of the wheat, is requisite to a much greater amount, than those of the barley; and the system to accomplish it, is therefore widely different.

Nor does the brewer stand less in need of the aid of chemical knowledge than the maltster, but indeed much more so: and as the generality of brewers are men of education, intelligence and liberality of sentiment, an acquaintance with this branch of science, would raise them from the condition, of unconscious imitative practitioners of their predecessors and teachers, and induce them to carry out improvements with a master mind, impelled by the force of conviction of their necessity, and the resulting advantages.

As the maltster is, so is the brewer taught; or rather he learns a series of practical operations, the whole of which are (perhaps to him) a mass of mysteries, as relates to the causes which produce certain effects, and effects which produce certain causes: he is but as a child, that assists to work the complicated and extensive machinery of the factory, instead of being as the conscious inventor, who comprehends and commands the movement of the whole, with ease, order and regularity.

He is a mere automaton, without knowledge, judgment, or skill, as relates to his profession or manufacture, if unacquainted with the theoretical department of chemistry.

He grinds or crushes his malt, probably without knowing, that an increase in the temperature of his malt is the resulting consequence; or if he does, he perhaps attributes it to an acquired heat arising from friction, instead of an abstracted heat resulting from decomposition. He probably mashes such malt with a menstruum regardless of its density, or whether the heat liberated from the malt, and converted from a state of latency to activity by grinding or crushing, is subsequently lost or not, or any other connecting circumstance that requires attention. He raises the temperature of the mashing menstruum, by the medium of burning fuel, but may be quite unconscious of the cause of its combustion. He adds water to malt and obtains wort, but the way in which the solution of the soluble materials of such malt is effected he knows not nor cares not. He adds to such water, heat, for accomplishing, facilitating, and accelerating solution, but he knows not the precise quantity of heat that should be imparted, and is calculated to effect his purpose, and a great portion of that which he does impart, he most improvidently loses, not providing the necessary mechanical means to prevent it, or wastes it by fruitless endeavours to effect mechanically, that which should be performed chemically. The process of solution he commences, progresses, and terminates in error, both mechanical and chemical. A stranger to the laws of affinity and attraction, he allows his wort to absorb oxygen to a baneful extent, and too often lavishes away his time, labour, strength, and pecuniary resources, "to save (as the adage renders it) at the spigot, and let run out at the bung hole." He pitches his tun with yeast, of the quality and condition of which, he is too often entirely unacquainted, and with its chemical powers, and the requisite quantity, and the cause and effect of fermentation, are as unintelligible to him as the operation itself. In fact, he begins a brewing, proceeds, and finishes it, a blind and unconscious agent in the performance of a chemical work, a stranger to the wonderful transitions which he has assisted to effect, and without a comprehension of the cause.

The brewer who has been merely taught, or has learnt a practical system, is in the same condition, as the mere practical maltster, when he endeavours to brew wheat malt alone, or in conjunction with barley malt. A rigid adherent to one single system, and that applied to the brewing of barley malt alone, the whole of his limited experience is confined to that practice, and if he attempts to travel out of it, he is bewildered and lost, being devoid of that universal light of general knowledge to direct his steps, or to prove a guide to lead him on his way.

ANOMALY, *irregularity, deviation from rule.*

Regularity, system, and rule, for conducting the general routine of business, are undoubtedly conducive to its prosperity; but (if the term may be allowed) anomalous regularity, system, and rule, should necessarily be adopted, in every branch of manufacture.

The manufacture of every article requires judgment, skill, and experience, which qualifications imply the necessity of a variation in the mode of operation, agreeable to the peculiar circumstances of each occasion, of which the judgment takes cognizance, experience directs, and skill executes.

If there was no variation in the quality and condition of grain, no difference in the temperature of water, or in the temperature and condition of the atmosphere; the maltster might then perhaps, pursue an invariable system with regularity, attended with uniform results.

If the brewer found his malt always of equal quality, condition, and temperature, he might adopt invariable mashing heats: and if his yeast was always of uniform quality, state, and condition, and the atmosphere continually of one temperature, and ever compounded of the same gases, in the same relative proportion; experience would very soon furnish him with a perfect and invariable system, which he might pursue with regularity, and experience uniform results: then easy indeed would be the process of malting and brewing! but such is not the case, nor can it ever be; and as both have to operate on materials of variable quality, and under varying circumstances, it becomes necessary that they should obtain that knowledge, which will enable them to judge of the quality of the materials they have to operate upon, all the variable circumstances to which their operations may be subject, and to adopt that variable mode of practice, as is suitable to every circumstance and case of emergency.

ANTIDOTE, *a remedy against, a curative of an evil.*

" Prevention is better than cure," is an adage, worthy of every attention, and by no one perhaps more than the maltster and brewer.

To purchase good grain, and in suitable condition for the purpose of malting, is cheaper and better than relying on, and having recourse to remedies, to improve the quality of that which is bad, and the condition of which is unsuitable.

It is cheaper and better to raise the temperature of the malting floors to a proper germinating heat, by mechanical or artificial means, than to rob the grain of that heat which is converted from a state of latency to activity in the process of germination, by the internal decomposition of the grain, in order to raise the temperature of the atmosphere of the room, to the right germinating heat, or what is technically called, " to get the house in good working order."

It is better to raise the steep water to a proper germinating temperature previous to steeping, rather than to lose time by extra steeping, and incur the resulting injury; and also to waste that portion of the internal source of heat, with which grain is furnished to assist the process of germination, in raising it to a germinating temperature.

It is much better to prevent the unnecessary waste of the steep water, after it has been imbibed by the grain, than to make subsequent additions of water by sprinkling, to replace that which has been improvidently lost.

It is better to admit light to the working floors, by small glazed windows without the accompanying admission of air, when light alone is needed, than from motives of economy to use unglazed shutters, and consequently be compelled to admit light and air together.

Solar light being inimical to the process of germination, it is not better to substitute for it, that light which emanates from the combustion of any fuel; because such light is equally adverse, with the additional disadvantage of causing the consumption of a large portion of the oxygen of the atmosphere, which is needed for the purpose of causing and facilitating the process of germination; and therefore as light is indispensable to the manual operations of turning, raking, &c. it is advisable to appropriate as small a portion of solar light, as is sufficient for the purpose.

As it is necessary that the carbonic acid gas which is evolved from grain in a state of germination, must be expelled from the working floors, and be replaced by atmospheric air, for the purpose of removing the one as an excretory product, and admitting the other as an impartative source of oxygen, it is necessary that the removal and the admission should be effected, without the loss of an undue portion of heat, in order to avoid the impartation of heat as an antidote.

If the impartation of heat to a malthouse working floor is necessary, it should be effected without the consumption of the oxygen of the atmosphere within the rooms, and without the abstraction of its moisture, lest the antidote to a too low temperature, should prove worse than the resulting evil.

To sweat grain before it is thrown on the kiln to save time, by accelerating the process of what is termed "mellowing," instead of taking time for the purpose by natural and judicious means, or as an antidote to the results of injudicious measures, is "to save at the spigot, and let run out at the bung hole."

To construct a malthouse or its kiln, on erroneous principles for the sake of economy, or to limit the size of the latter, to the capability of drying off in thirds instead of halves; or to throw on half a wetting instead of a third, upon a kiln of insufficient dimensions, is but a "penny wise and pound foolish" policy.

It is an absurdity for a brewer to build and fit up a malthouse and brewery, as the copy of any existing premises, for the sake of saving the charges of an intelligent architect, or the cost of enquiry, or obtaining information from some competent judge; inasmuch as the most trivial among the many errors which he may thereby commit, may cost him a much larger amount, than the purchase of the required intelligence.

As judicious simplicity is the distinguishing excellence of mechanism, and every chemical manipulation, so architectural simplicity in the construction of the malthouse and brewery; simple, yet suitable and consistent arrangements of all their departmental offices; few and well adapted utensils; simple and well adjusted machinery, will be the characteristic evidences of a well expended capital, resulting from the exercise of a well informed judgment.

To prepare malt improperly for infusion, as an antidote for the liability of taking improper mashing heats; to be subject to the liability of taking improper mashing heats, rather than pay the cost for its avoidance; to mash with oars or rakes to avoid the cost of a mashing machine; to infuse an improper period, under injurious circumstances, and by erroneous methods, in compliance with ancient prejudices; to refrigerate by air instead of by water; and numerous inconsistencies beside, are the stigmas which still adhere to the practical system of many brewers.

APATHY, *a want of passion or feeling, or energy, indolence, &c.*

" There is no royal road to knowledge," is an adage full of meaning, and which should be instilled into the minds of youth at an early age.

Indolence is a curse upon its possessor; and such an one may be compared to the upas tree, that sheds its deadly influence over all within its precincts.

Indolence is both positively and negatively injurious, committing and causing evil by example, precept, and mischievous action; and abstaining from doing good.

Apathy may be termed negative indolence, and mischief, active indolence.

Apathy loves to live an easy quiet life, taking every thing as it comes, contented with indolence, slow in motion, feeble in resolve, and tardy in execution.

Mischief is idle at work, but active at play; delights in the demolition of the products of industry, and is indefatigable in chacing the phantoms of the imagination.

Apathy in business is as machinery without oil: mischief as the broken main spring of a time piece.

Apathy is too often an inmate of our public schools, and youth are merely allowed to learn if they have the talent, the desire, and the perseverance to obtain knowledge; instead of being industriously taught, their minds cultured, their desires awakened, their emulation excited, and their diligence rewarded: and leaving the seminary of indolence, are often placed to learn and not to be taught, some business, manufacture, or profession. Removed from one situation of mental apathy to another, they pass the third septennial period of their lives, in acquiring idle habits, and inveterate prejudices, rather than scientific and practical knowledge; and when ushered into manhood, they grasp the reins of business, with an untutored and unskilful hand, and the chances are, they take the road of ruin to their destined end.

APPROXIMATION, *a near approach to any thing.*

An approximation to a good system, and a correct practice, is quite enough to satisfy many, and much more than enough to satisfy others.

Even those who are most desirous of attaining to a perfect method, seem to forget the adage, " that a miss is as bad as a mile."

The experimental and practical chemist well knows, that a successful result depends on the most scrupulous and exact attention to every minutiæ of the operation; and how often with indomitable patience, are they compelled to submit to the failure after failure of the performance of an experiment, until they have overcome all obstacles, and removed all difficulties, by indefatigable perseverance. Through such a school every maltster and brewer should pass, before he enters into either branch of business; that his mind may be expanded, his views enlarged, his patience tested, and his perseverance inured and strengthened.

The gradatory education of too many working maltsters, is obtained in the hovels of poverty, wretchedness, and ignorance, with an immediate transition to the malthouse, to learn and not to be taught, a practical system of malting, under a person as untaught as themselves.

It is the misfortune of too many brewers to be born in affluence, nursed in the lap of luxury, and with uncontrolled passions to have passed through the stages of infancy and childhood. The next period they are found at school, as the sons of fortune, to whom education is not necessary, as the means of procuring bread, but merely to adorn and fit them to pass with eclat, through the ranks of polished society. Released from such irksome durance, they are soon found in the sporting field, aiming at celebrity as good shots, and aspiring to all the honours of the chace. Somewhat sated with all the joys of these pursuits, and a little tamed by matrimony, they begin to turn their attention to business, with a view to fulfil all the duties toward an expectant family. And what shall be the employment of the heir apparent, or the young proprietor? Certainly not an inferior avocation! Nothing less than the highest post will suit the presumptive or acquired master!

The brewing department alone, with the attainments of a mere glance at such superficial knowledge, is quite sufficient for his purpose! To take the mashing heats and weigh the worts, is quite sufficient for him! All the rest can be performed by the well organised menials. His father did well by it, and what can he need more?

If this is a faithful portrait, yet too severely drawn to flatter or to please, it may correct, and thus fulfil its purpose; and while some may discover in it, a close or an approximative resemblance of their own lineaments, there are others whose features it will not represent.

But it is never too late to learn! and there are many perhaps, who have passed their youth in idleness and dissipation, and have neglected the golden opportunities of acquiring knowledge when young, yet are truly desirous to learn, when they become convinced of the utility, and solidly gratifying pursuits of science, and have lost the relish for the unsatisfying and cloying products of irrational pleasures.

To such as have thus passed the meridian of life, may be recommended, an endeavour to attain to an approximation to replete acquirements, rather than to abstain from all researches, on account of the difficulties in the way.

Accuracy in the minutiæ of the practical details of the manufacture of any substance, is absolutely necessary to the production of good quality, and corresponding advantages; knowledge is necessary to direct the application of industry, perseverance, and attention to the minutest portion of every process; and the entire devotion of such qualifications, to the realization of successful results.

It is a fatal error fallen into by many brewers, induced by monopoly, the absence of competition, and the presence of wealth, to treat, what they call, an unnecessary attention to trifles, with absolute contempt: but the partial opening of the trade by the legislature, indicative of the liability of the removal of all restraint, to a still further extension of the recent expansion; ought to be a sufficient warning to those who are already in the field, to prompt them to seek a favorable position in public estimation, by the acquirement of knowledge, the adoption of improvements, and a strict attention to every minutiæ, of each department of their business: and they should bear in mind, the propriety of moving with the rapid current of public opinion, and the swift "march of intellect," rather than endeavour to stem the torrent, by the puny efforts of remonstrance and complaints, against the innovations of the day.

An approximation only to a good system, and to an accurate attention to its details, will not suffice in the day of free trade, and energetic competition; and nothing less than an extensive and comprehensive knowledge, is sufficient to induce those improvements, which the altered state of trade requires.

AREA, *superficial content.*

It is truly desirable and advantageous, that the master should comprehend, and be able to perform all the minute operations of his business ; and therefore the maltster should be able to ascertain the contents of his steeping cistern and couch, and gauge his floors, in order that he may discover, if justice is done to him in the charge of his duties. The brewer should also be able to gauge his utensils, as a matter of convenience and satisfaction to himself.

As it is necessary to find out the area of a cylindrical vessel previous to the discovery of its contents, the following rule, will exhibit the method, by which the content of such vessel may be ascertained at the depth of one inch, or any number of inches.

Rule. Multiply the diameter of the cylinder by itself, and that product multiply by the depth in inches and decimal parts ; lastly, multiply this last product by the decimal 0028 (the imperial measure multiplying decimal) and add to such product, one-third of the multiplicand, and from this product, cut off as many figures as there are decimals in the whole, and the figures or whole numbers are gallons, and the decimals are parts of a gallon.

EXAMPLE.

Find the area or content of a cylindrical vessel at the depth of one inch, whose diameter is twenty five inches, five tenths.

25,5	the diameter
25,5	the do.
127,5	
1275	
510	
65025	
1	the depth.
65025	
0028	the imperial multiplying decimal
520200	
130050	
1820700	
21675	add one third of the multiplicand
1,842375	content of a vessel at a depth of one inch
12	
22,108500	content of vessel at a depth of twelve inches, in gallons and decimal parts

To ascertain the area and content of a vessel, whose form is a parallelogram, (imperial measure) take the length and breadth, and reduce them into inches, and multiply by each other, and the product divide by 277,274.

EXAMPLE.

Length 12 feet or	144 inches	
Breadth 4 feet or	48 ditto	
	1152	
	576	
Divide by 277,274)	6912.000	(24 gallons content at one inch depth
	554548	10
	1366520	240 gallons at 10 inches depth
	1109096	
	257424	

ATMOSPHERE, *the gaseous fluid which surrounds the earth.*

Air and atmosphere are distinct terms; the former is used to denote that fluid, which surrounds the earth in a state of purity, or unmixed with adventitious gases, vapours, &c. and the latter to denote such fluid, in a state of admixture with gases, vapours, &c.

As in a natural state, pure air does not exist in the vicinity of the earth's surface: all animated beings inhale in breathing and are affected personally or relatively, by an atmosphere of varying degrees of purity, proportionate to the quantity and properties of the gases and vapours mixed with pure air.

The temperature of such atmosphere, and the intensity of its chemical and locomotive action, are considerations of paramount importance, as relates to its effective powers on the animal system, and all the products of creation.

In breathing man inhales atmospheric air, generally, at a much lower temperature than the heat of his body; yet is his body supplied with the heat (paradoxical as it may appear) by the atmospheric air inhaled; and maintained by the regularity of the supply of air, and the escape of heat from the external surface of the body.

At every inspiration of the lungs, a considerable quantity of atmospheric air is drawn in, and is decomposed within the lungs. The consequences of such decomposition are, the separation of the oxygen therefrom, which unites with the blood, and the subsequent ejection from the lungs by expiration, of the other constituent portions of the atmospheric air, which had been inhaled, and the liberation and conversion of the latent heat of the atmospheric air into a state of activity, which also unites with the blood, and which flowing from thence to the heart, is circulated throughout the system, conveying the heat received in the lungs to every portion of the frame, and from the external surface of which the superfluous quantity is imparted to the atmosphere.

The vapour with which such atmospheric air is charged, serves to lubricate the membraneous surface, over which it passes to the lungs; and the salubrity of such air, is proportionate to the quantity and quality of the adventitious gases, and the quantity of vapours mixed therewith.

After the decomposition of such air within the lungs, and the impartation of its oxygen and heat to the blood, the residue is ejected by respiration, and being deprived of its oxygen, that which is emitted is deleterious; and being lighter than atmospheric air, it ascends the moment it is ejected, and a short pause ensuing before another inspiration is made, that which has been emitted from the lungs, has time to escape without the liability of its being inhaled again. Thus by this wonderful and admirable system of animal economy (which furnishes one of the myriads of proofs of the wisdom, omnipotence, and beneficence of its author) are all created beings supplied with life and heat.

Atmospheric air being the impartive and abstractive medium of heat to the human body, the standard natural temperature of the blood being at about 98 degrees of heat, and man being endued with an instinctive desire, to preserve every part of his body at that equilibrium temperature, a very considerable portion of his time, ingenuity, contrivance, care and attention, is employed to maintain it, either by the acquirement, retention, or impartation of heat from and to the atmosphere.

If the instinctive sensations denote a reduction of the temperature of the body, below an agreeable amount, an acquirement of more heat from the atmosphere is effected by walking, running, or other action, which causes an accelerated motion of the respiratory organs, resulting in the inspiration, and decomposition of a greater amount of atmospheric air, and consequently the impartation of more heat to the blood, and the circulation of which being also proportionately accelerated, an increased temperature of the whole of the body is the consequent effect.

To retain such heat, as is thus, or otherwise acquired from the atmosphere, induces the appropriation of suitable clothing, to shield the external surface of the body, from the access of too large a quantity of atmospheric air; and it is the province of the mind to direct the will, to regulate the quantity, quality and properties of such clothing, and the various changes of apparel, and an increase and decrease of the amount, as induced by the various circumstances to which the body is subject, in order to preserve the equilibrium of its temperature. And the mind is ever promptly informed, of the slightest variation in the amount of temperature, in the most remote members of the body, above or below that which is agreeable, by a telegraphic conveyance of the intelligence by the nervous system; and the will is as promptly directed by the mind, to seek the acquirement of more heat from the atmosphere, the retention of more heat by the intervention of more suitable or a greater quantity of clothing, to retard the celerity of transmission to the atmosphere of such heat as is already possessed, or to place the body in the vicinity of some hotter medium than itself, in order that the suffering member may derive heat therefrom.

As the usual temperature of the atmosphere is much below that of the human body, there is but little or no difficulty in preventing the accumulation of too much heat within the body, as the atmosphere ever presents a ready medium, for the abstraction of the superfluous quantity: and a partial or total uncovering of any part of the body, which experiences the unpleasant sensation resulting from too great an accumulation, will afford the required relief, by removing the impediment to the transition of the superfluous heat to the atmosphere.

ATOM, *an extremely small particle.*

All created substances are supposed to consist of an assemblage of atoms; the inducement to union being affinity, the accomplishment of union, simple and aggregate attraction; and the bond of union, attraction of cohesion.

The form, magnitude, and properties of atoms, have not yet been discovered by man. His ingenuity has not yet furnished him with the means to ascertain the facts of the case, and therefore he has presumed to frame hypotheses relative thereto, deducing the basis for their structure from analogous circumstances; and from them, we select the following, as coincident with our own views, and in best accordance with all the analagous facts, that have come beneath our notice.

The form of atoms are supposed to be spherical, that they are divided into classes, each class possessing distinct and different properties.

The primary division comprehends, ponderable and imponderable atoms, each of which are subdivided into secondary classes.

As sufficient for the purposes of this work, we shall only notice the subdivision of the ponderable atoms into four classes, denominated oxygen, hydrogen, carbon and nitrogen, and imponderable atoms into two classes, denominated heat and light.

The primary property or characteristic of the ponderable atoms, consists in a tendency with which they are endued, to fall toward the centre of the earth, denominated the law of gravity; and the primary property or characteristic of the imponderable atoms, consists in a tendency to recede from the centre of the earth, denominated the law of recession.

The secondary properties or characteristics of the ponderable atoms vary, each class possessing its peculiar properties.

The secondary properties of the imponderable vary, each class possessing its peculiar properties.

The imponderable atoms are supposed to be of less dimensions than the ponderable.

The arguments in favor of the spherical form of atoms, which are adduced, are, that as bodies by decomposition liberate heat, and as the atoms of solid bodies must be closely united by the power of attraction of cohesion, there must be interstices to contain the atoms of heat; and as the spherical form is the best adapted to furnish the necessary interstices for the advantageous store of such heat; so doubtlessly that form was wisely ordained, whose adaptation was the most suitable.

Again, if a sufficient quantity of heat is infused into a solid body, as to overcome the power of attraction of cohesion, which held those atoms together, and thereby constituted it a solid body; and separate the ponderable atoms, and remove them to a distance from each other, but not beyond the sphere of aggregate attraction, and thereby convert the solid into a liquid or gaseous fluid; that as the atoms constituting such liquid or gaseous fluid, yield to pressure in every direction, they must be capable of moving with the utmost facility; and as no form is so well adapted as the spherical for such a purpose, the inference is drawn, that doubtless such a form is chosen.

In support of the theory, that atoms are spherical, and that the imponderable atoms are smaller than the ponderable; the permeation of solid bodies by heat and light, without the separation of the ponderable atoms one from the other, may be adduced; for as the permeation without displacement, evidently proves the existence of spaces, or interstices, between the ponderable atoms; and no form is so well adapted as the spherical, to furnish those necessary spaces or interstices; and as all the works of creation are perfect, it is presumed that the spherical form for atoms was chosen, as the best adapted for the various modifications for which they were created: and again, as the interstices presented by the union of spherical atoms, are not equal in dimension to the atoms in union, so therefore, as the atoms of heat and light are able to pass through those interstices, they must necessarily be of less dimensions, than the ponderable atoms composing those solid bodies.

As an illustration of this theory, take a glass tube containing mercury, such as apertains to a thermometer, and plunge it into hot water; and it will be found that the mercury increases in bulk, by the transition of atoms of heat from the water to the mercury, through the interstices that are presented, between the ponderable atoms of which the glass tube is composed, and which are in close contact with each other; and as it is evident that the atoms of heat pass through those interstices into the mercury, and the ponderable atoms of which the mercury is composed, do not pass through those interstices into the water, the inference must necessarily be, that those interstices are of less dimensions than the ponderable atoms in union of which the glass is composed, and also those of which the mercury is composed; and that the atoms of heat being smaller than the interstices, must necessarily be smaller than the ponderable atoms of either.

If it should be doubted, that the expansion of the mercury is occasioned by the transition of atoms of heat from the water to the mercury, through the glass tube, it may be proved analagously, by filling a vessel quite full of cold water, and placing it in a vessel of hot water; and it will be found, that a quantity of heat will pass through the superficies of the inner vessel, and continue so to do, until the temperature of the water in each is equal, and the water in the inner vessel will expand and run over, while the water in the outer, will contract and diminish in bulk.

And again, a vessel may be filled with cold water, and burning fuel be placed beneath it, and it will soon be found, that by the transition of heat from the fuel to the water, through the bottom of the vessel, that the bulk of the water will be increased.

That atoms are divisible into classes, the analysis of every substance sufficiently demonstrates; water is divisible into two classes, oxygen and hydrogen; air into oxygen and nitrogen; and many substances are found to be compounded of atoms, of other and more classes.

Both maltsters and brewers, are deeply interested in the subject of atomic changes, as the whole of their operations in the manufacture of malt and beer, consist, in effecting a transfer of atoms from one body to another, and both knowledge and skill are requisite to effect it in right proportions and to a correct extent: and to speak in illustrative language, it is the business of the maltster, to transfer the oxygen and heat of water and the atmosphere to grain, and to abstract carbon therefrom. And it is the brewer's business, to transfer a portion of the atoms of which malt is composed to water, in order to obtain the compound called wort; and subsequently to impart oxygen from the atmosphere to such wort, and to withdraw carbon from it: and if such transfer is the basis of all their operations, (and who can doubt it) surely it is quite necessary, that they should be well acquainted with the atomic classes, their combinations, and the several laws to which they are subject, and by which the various transfers, changes, and interchanges of atoms are effected.

ATTENUATE, ***to thin, weaken and dilute.***

The primary purpose of a distiller, is to obtain as much extract as he possibly can, from malted and unmalted grain mixed, and the brewer from malted grain alone. The secondary object of the former, is to attenuate his wort, (the product of extraction from grain, &c.) to the utmost extent by fermentation; his object being the production of as much spirit as is possible: and the secondary object of the latter, is to attenuate his wort by fermentation to a moderate extent, his purpose being to produce a moderate quantity of spirit, and to retain a certain portion of the extract unfermented, in order to gratify the taste of the consumers by a retention of its sweetness.

The distiller's difficulty is, to furnish an incentive to fermentation sufficiently powerful, as to attenuate the whole of the fermentable matter his wort contains, or as much of it as is practicable; as his profit depends on the quantity of spirit which he can produce at the least cost. The brewer's difficulty is, to furnish an incentive to fermentation of that medium effective power, that is sufficient to cause an attenuation of his wort, to a required medium extent; his object being the production of a certain measure of spirit, the retention of flavor and sweetness for the palate, and the creation of a moderate quantity of carbonic acid gas, to gratify the eye and taste.

The term attenuate as applied to wort, is intended to express the reduction in the specific gravity or density, which occurs by the process of fermentation; and the instrument used to ascertain the amount is called a saccharometer. Thus if the density of a wort previous to fermentation is 30lbs per barrel, as indicated by the saccharometer, and its density is but 10lbs per barrel by the same indicator, subsequent to fermentation, it is said to have been attenuated 20lbs, or attenuated to 10lbs.

Attenuation then means, a reduction of the weight of a wort, effected by fermentation; and this reduction in weight is caused, first by the absorption of oxygen by the wort from the atmosphere; by the union of such oxygen with the carbon of the wort; by the consequent formation of a new compound called carbonic acid; by the further consequences of the combination of the carbon and oxygen in liberating imprisoned heat, (in such state termed latent) and which heat uniting with the carbonic acid converts it into carbonic acid gas; and being converted into gas of less specific gravity than the surrounding medium, it ascends to its surface, and finally rises in the surrounding atmosphere; and thus an abstraction of a portion of the ponderable atoms of which the wort is composed occurs, thereby diminishing its specific gravity.

The endeavour of the distiller is, to attenuate his wort as low, or lower than water; which means, that any given quantity of wort, which previous to fermentation weighed heavier than an equal quantity of water, is so far reduced in weight by fermentation, as to be of the same, or less weight than water. But it must not be inferred from this, that the whole of the extract contained in such wort, has undergone that change, which the most considerable portion of it has done: for as such fermentation has caused the production of spirit, and spirit is of less specific gravity than water, so when the fermentation has ceased, although the specific gravity of the fermented wort may be the same, or less than water, yet if the spirit is separated from it by distillation, the spent wort or wash, will be found of much greater specific gravity than water.

ATTRACTION, *the power of drawing or enticing.*

The author of all created things, and the superintendant of the wonderful and stupendous operations of nature; hath in his consummate wisdom, furnished the atoms of matter with a desire to unite, and which desire, man has designated with the term affinity.

He has also supplied them with those peculiar tendencies and dispositions, which are equivalent to the affections and antipathies of the human race; whereby union is prompted, controlled, and prevented, in all the varieties of a well organised system, instead of an indiscriminate and chaotic union.

In addition to this tendency, he has gifted them with the power to unite, when brought within a certain distance of each other, which distance is called the sphere of attraction; and which power is called simple attraction as applied to two atoms not united, and aggregate attraction as applied to two or more atoms already united, acting upon one or more atoms not in a state of union with them. Thus two atoms placed within the sphere of attraction, and free as relates to motion, are drawn together, and unite by simple attraction; and when the union is effected, both atoms are still in possession of the power to attract others, and consequently the attraction is aggregate, because both atoms exercise an influence, in attracting a third or more atoms to themselves; and being once united, the power which perpetuates their union to each other, is called attraction of cohesion; and they cannot be separated, but by a power superior to that which holds them together.

As illustrative of this theory, we may refer to aqueous vapour, which is composed of the atoms of oxygen and hydrogen, which have an affinity for, and attraction to each other; but which are kept separate from each other to a considerable extent, by the intervening and commixed atoms of heat, but not beyond the precincts of the sphere of attraction of aggregation; and if a portion of the atoms of heat are withdrawn, the atoms of oxygen and hydrogen will draw closer together; and if a sufficient quantity of the atoms of heat are withdrawn, the vapour will be reduced to an aqueous fluid; but still in such state, the atoms of oxygen and hydrogen are not in close contact, being kept separate by the quantity of heat yet left. The abstraction of more heat is necessary, to enable the atoms of which the aqueous fluid is composed, to unite in close contact; and this is effected by the process called freezing, when they cohere together and form a solid body called ice. Reverse the operation and proceed as follows: take ice which is composed of the atoms of oxygen and hydrogen, united together by attraction of cohesion, and impart to it heat; and such heat will first fill all the interstices presented by the union of the atoms of oxygen and hydrogen; continue the impartation of heat, and it will next overpower the attraction of cohesion, and the atoms of oxygen and hydrogen will be separated one from the other, and the ice will then have been converted into water; and the amount of heat imparted to the ice previous to its conversion into water, is called the caloric of fluidity, or latent heat; because such ice being at a temperature of 32 degrees previous to its solution, and having had a considerable quantity of heat imparted to it, to convert it into water, and not more than sufficient for such purpose, the water indicates no greater temperature than did the ice, consequently all the heat which has been imparted, has become latent or inactive. Continue to impart heat to the water, and the atoms of oxygen and hydrogen will be still further separated, and eventually the water will be converted into vapour or steam; and yet the atoms of oxygen and hydrogen will be still under the influence of attraction of aggregation; and to place those atoms beyond such influence, requires the impartation of an immense quantity of heat, and which when imparted, effects a decomposition of the aqueous vapour, dividing the atoms into their respective classes, and liberating them for the formation of new compounds.

ATTRIBUTE, *to ascribe, impute, assign, yield.*

Many of the strong prejudices existing in the minds of brewers, are attributable to their ascribing many effects to wrong causes, for want of knowledge, due enquiry or consideration.

Such erroneous prejudices are injurious, inasmuch as they induce the adoption of improper measures which lead to unprofitable results; and they prevent the reception and obtainment of valuable information, which would induce judicious improvements ensuring profitable remuneration.

In the absence of sound, definite, and perspicuous theoretical knowledge of the subject of malting and brewing, there must be a great diversity of opinion relative to practical systems; and the method which is recommended by one maltster or brewer, will be strongly deprecated by another; or two or more may adopt the same system, yet owing to their carrying the practical details into operation in different ways, or such operation being influenced by varying circumstances, they may experience very different results.

The fault then may not lay in the system, but in the want of a comprehensive knowledge of it, and all the circumstances that may or do affect the operation in executing the details, and the favorable or injurious results may be attributable to the perception and skilful appropriation and control of those circumstances; or the imperception, misappropriation, or unrestrained influence.

The great error which many manufacturers fall into is, the seeking of systems without an endeavour to obtain a knowledge of the proper method by which they may be successfully worked. They hear that some cotemporary is producing an article of better quality, or is realising a greater profit than themselves, and they become very anxious to learn the secret without pecuniary sacrifice, personal application, or laborious research; and if they become possessed of the substance, it proves as but a shadow in their grasp, because they know not how to appropriate it, or they apply it upon wrong principles; and that which proves to others an advantage, is to them a source of injury and loss.

AVAIL, *to profit, prosper, assist, promote.*

Few there are, who avail themselves of the opportunities which they have to learn, to say nothing of those which they might have, provided they had a desire to acquire knowledge, regardless of all difficulties.

The young put off the irksome task until a future day; and when that day arrives, in which they feel the necessity and advantage of learning, the cares and multifarious avocations of a life of business, choke up all the avenues to scientific knowledge, and the man laments the ill spent hours of youth.

Few need more the admonition, "seek knowledge while she may be found," than those who depend on the profits of manufacture, for subsistence, competence, or affluence. The numerous and incessant changes induced by fashion, public taste and opinion, require a general and extensive knowledge, that will admit of an adaptation of system, commensurate to every case of necessity; and the ductile mind that is well versed in expediences, can float his bark in calm serenity upon the stream of prosperity, while the inexperienced, the ignorant, the prejudiced, and obstinate opposers of improvement, and who vainly strive to stem the torrent of public opinion, are run down and engulphed, unpitied and unknown.

AVARICE, *covetousness, an insatiable desire.*

A desire to gain is a legitimate and commendable passion, provided it does not exceed prudent and reasonable limits, in the endeavour to obtain the necessaries and comforts of life, for self and relative enjoyment, and all beyond for the purpose of benevolent diffusion.

To get gain without the daily moderate use and dispensation of the products, is but the application of cankerous care to the mind, which corrodes and destroys all intellectual gratifications.

To make haste to get gain beyond the natural progress of legitimate profit, is as to run a race upon a course, whose confines are bounded by deep precipices.

Evasion of duties, adulterations, frauds, speculations, and extensive experiments, are some of the steep and craggy cliffs that ensure the destruction of swift footed avarice.

AVOLATION, *the act of flying away.*

If any proofs were wanting of the great need of a very small portion of a knowledge of the rudiments of brewing, the opinion expressed by some brewers, on the subject of the evolation of vapour from the surface of wort in the copper, and in the cooling backs, &c. and of carbonic acid gas from the surface of wort in the fermenting tuns, would afford a sufficient demonstration of the fact, and the advantage that would accrue to themselves, if some of their crude and absurd ideas, would " take to themselves wings and fly away."

To refer to some of the erroneous ideas relative to the subject of avolation, which are entertained by some brewers, they imagine that in the process of boiling wort in the copper, and in the subsequent process of cooling it in the cooling backs, that it experiences a loss in value, by the evolation of vapour from its surface, on the supposition, that with such vapour, there is an evolation of a portion of the malt extract; and some go a step yet further in absurdity, conceiving that in both cases a loss of spirit occurs.

A little elementary knowledge would be sufficient to convince the first class, that with the exception of the evolation of a little essential oil, in the process of boiling and cooling, nothing but pure water in the form of vapour is evaporated; and the second class, that no spirit can be possessed by unfermented wort, and consequently, none can be evaporated from it in boiling or cooling.

There is a third class, who although they may be well aware of the erroneous views adopted by the preceding, yet fall into the error of endeavouring to prevent the evolation of spirit and carbonic acid gas from wort in a state of fermentation, by conducting the process in closely covered fermenting tuns, incorrectly supposing, that spirit will evolate from the surface of the wort, at the temperature at which vinous fermentation is usually effected, and that the loss of carbonic acid gas is injurious. But a little elementary knowledge would convince this class also, that spirit cannot evolate from fermented wort, but at a much higher temperature than it is usual or prudent to allow it to attain to, during the process of vinous fermentation; and that nature is too wise and skilful, to cause or allow an evolation of an excretory product of any of her operations, without an absolute necessity for its abstraction, and an advantage resulting from its removal. And presumptive indeed must the person be, who would attempt to oppose her course, or question the propriety of her transactions; and therefore to restrain or prevent the free and easy evolation of the carbonic acid gas, which is generated in the process of fermentation, is to endeavour to oppose, and controvert every purpose for which it was created, and without the evolation of which, such purpose cannot be advantageously fulfilled.

In contra-distinction to the first two classes, are a fourth, who forego the chemical and mechanical advantages, resulting from the use of a dome or close copper, and a refrigerator, because they possess some indefinite notion, that there is nothing like the old fashioned way of brewing; and that a free evaporation from the copper and the cooling backs, effects an abstraction of something from the wort, which they think it is desirable and necessary that it should be freed from, but what that something is, they cannot tell, or furnish an idea of.

AXIOM, *a self-evident proposition, a maxim.*

Axioms and proverbs are of incalculable utility, in inculcating upon the mind, incontrovertible and well-established truths, and are equally serviceable to manufactures, trade and commerce, as to morals, &c.

And it is presumed that a few axioms, proverbs, and maxims, addressed to those for whom this work is intended, will not prove unacceptable.

"Knowledge is power," inasmuch as it enables its possessor, to govern, direct, advise, and control others, to an extent, in the inverse ratio, to the superiority of his attainments above theirs.

Knowledge is the key that unlocks the secrets of nature, unravels her mysteries, developes her treasures, and enables its possessor to partake largely of her bounties.

Knowledge dispenses sustenance and health to the body, and inexpressible pleasure to the mind.

Knowledge never cloys, but imparts a zest to the mental taste, an increasing impulse to its appetite, vigour to the intellect, strength to the judgment, wings to the imagination, and the confines of space to the soarings of the soul.

Nothing is too trivial to know and understand. Something may be learnt from every one, even from the most ignorant.

Every business has its rudiments or first principles, and gradatory stages, from the lowest to the highest of its avocations; and those who commence at the pinnacle, must travel downward; but those who begin at the base, may climb upward.

"There is no royal road to knowledge."

Nature is man's teacher, and she bids him to imitate her works. Her materials are few; her system is simple; her laws are unerring; her arrangements are admirable; her adjustments are wonderful; her resources are inexhaustible; and her performances are perfect. She is the ideal representation of providence. Who would not study such a model? And who would not be her pupil?

Be open to conviction, and impenetrable to prejudice.

Take nothing upon trust, but examine for yourself.

Reject nothing without analysis, there may be metallic truth among the apparent rubbish of intelligence.

From small beginnings large results ensue.

Begin well, go on well, and the probability is, that you will end well.

What one person has done, another may do, therefore never despair of being able to do, that which you have resolved to try to perform.

"All is not gold that glitters," nor does the diamond shine until it is polished.

Weigh well an offer, nor judge of its value by the owner's reputation.

Skim the surface and you will lose it; dig deep and you will find it.

Solve all problems in the mental crucible of reflection; and if they are hard, apply the fervid heat of application.

Let the means be equal to the end. Do nothing without a worthy motive. "Honesty is the best policy."

BANEFUL, *poisonous, hurtful, destructive.*

As ignorance in physics induces quackery, so does a want of knowledge of the scientific principles of manufacture, lead to adulteration and imposition; and none are greater dupes to, and sufferers by their own system, than those who practice either.

Regardless of the baneful consequences of adulteration, and strangers to the impolicy of deception, they are ever seeking illicit and pernicious ingredients to enhance their profits; ever meeting with impostors and unprincipled persons to recommend them; ever the slaves of their own servants; ever apprehensive of detection; ever experiencing loss by irregularity and disorder, resulting from the seeking of an opportunity to use them; and never, in the long run, deriving benefit equal to the loss sustained.

Let the hop grower, who is negligent in picking, allowing the leaf and stalk to be mixed with the flower and seed, for the sake of making up weight; in the habit of slack drying, of exposing them to a humid atmosphere, or imparting water, after the excise have weighed them, bleaching on the kiln, &c. say, after an exhibition of his name on each pocket for a few years, whether or not he has gained by the nefarious system.

Let the maltster, who has bought inferior grain at a low price, trusting to his skill in making up a fair sample to the eye, by working it to excess to make it bite free and measure well; by bleaching it on the kiln, and plumping it with water in drying, or after it is dried; who has had recourse to an illicit system of working, to suit the errors of practice or to run the duty, say, after a few years' experience, if he thinks he has gained anything by deviating from a straight forward course of integrity.

Let the brewer also, who has perhaps been induced to become his own maltster, impelled thereto, by the nefarious practices of the selling maltster, because he is conscious that he can make a better and cheaper malt than he can purchase; and who is just to himself in the malthouse, but unjust to the public, and injurious to himself in the brewery; and who has been prompted to use pernicious drugs, under the fallacious notion of deriving extra profit; say, after trying the whole course that has been recommended to him, by treatises on brewing and interested vendors, whether or not, practical experience has convinced him, that there is nothing so cheap and good as malt and hops for the purpose of brewing; and that all drugs are worse than useless, either as a substitute or an auxiliary; and let him ascertain the properties of such as he has used, and he may discover the probable extent of the baneful evils which he has caused, without even accomplishing his object—the welfare of himself.

BARLEY, *a description of grain that malt is usually made of.*

The illimitable bounty of providence, has not only furnished an abundance for the sustenance of every living creature, but a lavish supply of innumerable species of food, admirably adapted in extensive variety, to minister to the gratification of every taste, and to nourish every constitution.

Barley forms one of the species, intended peculiarly for the use of man, and although convertible into solid food, yet its natural purpose is for the supply of a nutritious and medicinal liquid aliment, in the form of beer and spirit. And although apparently intended by the wisdom of providence for such peculiar purpose, and each species of grain for the several purposes to which man has instinctively appropriated them; yet has he wisely, and most beneficently furnished the requisite properties to each, as will admit of their convertibility for either purpose, as circumstances and occasion may require. Thus as barley is naturally intended to furnish liquid food, and wheat to supply solid, yet are both capable of a reversed appropriation, when necessity or other motive induces.

Barley may then by the usual mode of appropriation, be considered as the staple species of grain, for the production of spirit in its unmalted and malted state, and for beer in its malted state: but it is customary for distillers to compose their grist, with a small portion of malted barley, a large portion of unmalted barley, and a medium portion of unmalted oats; the purport of the admixture being, to form a grist of such a specific gravity, as is suitable for the process of solution and extraction; and of such a composition, as is adapted to produce a wash suitable for vinous fermentation; and of such proportions as relates to the charge for duty on malt, and the relative prices of barley and oats, as will combine the requisite conditions at the least cost.

There are a great variety of species of barley, and some better adapted for conversion into malt than others; and there are certain states and conditions in which each species may be, which renders them more or less calculated for the production of good malt; and there is ample room for the exercise of the judgment, in selecting such species and attending to the state and condition of each, so as to ensure the most profitable results.

BEER, *a liquor made of malt and hops.*

The term beer is used by many, to denote every sort of malt liquor, whether ale, porter, or table beer, while some apply it to porter only; but as a general term, expressive of every sort, the appropriation seems most suitable.

Beer may be considered as an indigenous product of the British Isles, being manufactured and consumed to a much greater extent by their inhabitants, than by an equal population of any nation on earth: and being the popular beverage, its manufacture is of the first importance; and being a chemical production, a considerable portion of scientific knowledge is necessary, to ensure that quality which will satisfy the most fastidious taste, rendered critically acute by habit and experience.

The diversity of sorts and strengths, are the creations of expediency, to suit the pecuniary means and capricious desires of every consumer; and it is to the interest of every brewer, to obtain by knowledge, experience and skill, the means of brewing beer of superior quality, at the least possible cost; and to supply it to the public at fair prices, or such as competition may induce.

Superior quality as applied to beer, is an arbitrary and capricious designation, inasmuch as there is no definite standard of perfection of universal assent, and what one person calls superior, another will call inferior, and it therefore becomes a necessary part of a brewer's study, to ascertain the peculiar flavor, condition, and age, that will best suit the majority of his customers, and others whom he wishes to obtain as customers; and the term superior, may be applied to such beer as pleases them most.

To brew beer of superior quality at the least possible cost, does not imply either the necessity, propriety, or advantage, of the use of any ingredient beside malt and hops; but on the contrary, the opinion is, that no substitute or subsidiary materials will so well accomplish the double purpose, as malt and hops alone.

The conditions then, to ensure superior quality at the least possible cost, are, good malt, hops, water, yeast, and isinglass; and a thorough and complete knowledge of the theory and practice of brewing: also well adapted premises, and suitably fitted up for the exercise of skill, and the performance of the operation at the lowest possible scale of expenses; accompanied by the requisite care and attention, in effecting the greatest production, and to suffer no unnecessary waste.

BOIL, *that agitation of a fluid called bubbling, occasioned by the impartation of a sufficient quantity of heat.*

Various fluids boil at different temperatures, both in vacuo, and when exposed to the pressure of atmospheric air.

In the latter case, water boils at about 212 degrees (Farenheit) of heat, and alcohol at about 176 degrees.

The common mode of imparting heat to a fluid, is through the bottom and sides of the vessel in which it is contained; but in what way heat passes from the burning fuel to the fluid through the vessel cannot be perceived, as heat is to man, an imperceptible substance, evolved from fuel in a state of combustion or decomposition, and consequently he cannot take cognizance of the transmission from ocular demonstration.

The mode by which the transition is effected, is therefore at present hypothetical, and a vague opinion is all that can be furnished illustrative of the case, in the present state of human knowledge. Agreeable then to such declaration, the following hypothesis relative to the transmission of heat through the vessel to the fluid contained in it is offered.

It is supposed, that the vessel is composed of spherical atoms adhering to each other, by attraction of cohesion; the fluid in the vessel is also composed of spherical atoms, held together by attraction of aggregation, but not by attraction of cohesion; and that heat is also composed of spherical atoms endued with the power of transmission from one body to another, until both bodies possess an equal quantity of heat. It is further supposed, that the atoms of heat are smaller than the atoms of which all substances are composed, and sufficiently small, as to be able to pass through the interstices which are presented, when such atoms are united together by attraction of cohesion, touching one another only at points, and consequently leaving a space for the passage of atoms of heat.

The fluid in the vessel, possessing less heat than the burning fuel, atoms of heat, impelled by (what may be termed) the law of equal diffusion, pass through the interstices presented by the atoms of which the vessel is composed, and enter into the fluid. The effect of such entrance is to increase the bulk of the fluid, which increase is called expansion; and the circumstance of such increase occurring, appears to corroborate the opinion that the atoms of heat are material.

If the vessel contains water, the transition of heat from the fuel to the water, continues without causing ebullition until the temperature of the water is raised to 212 degrees of heat, as indicated by Farenheit's thermometer, and above which heat it cannot rise, while subject to the usual pressure of the atmosphere. It is not to be supposed, that because the temperature of the water does not continue to rise after it has attained to 212 degrees, that no further transition of heat to the water occurs; but as the water is converted into steam, all the additional heat imparted passes off with the steam generated. As soon as a sufficient quantity of heat is imparted to water, to convert the upper surface into steam, the temperature of fluidity of that surface ceases, and the temperature of vapour commences; and as the lowest temperature of aqueous vapour is 212 degrees, the upper surface of the water, must be at such a heat before steam can be evolved from it; and as the whole body of the water in the vessel does not indicate a temperature of 212 degrees by the thermometer, at the time steam first begins to rise, it may appear to some, that the temperature of fluidity is not so high as 212 degrees. But nevertheless, such is the case; and it is easy to account for the fact, upon the well known principle, that heat always ascends in obedience to the primary law to which it is subject; and laterally or downwardly, in obedience to the secondary law, or law of equal diffusion, to which it is subject; and although the whole of the heat may be transmitted to the water, through the bottom of the vessel which contains it, in obedience to both laws, (the one not opposing the other) yet the moment it has passed, it ascends to the upper surface of the water, in obedience to the first law; and the upper surface is consequently hotter than the lower, or any intermediate distance between; and continues so during the whole period of transmission, until the whole bulk attains to a temperature of 212 degrees; which can only be effected by the impartation of heat through the bottom, being more rapid than its escape from the upper surface; when in such case the temperature of the whole bulk is gradually raised to 212 degrees, from an accumulation of heat at the upper surface, extending by incremental progress downwards to the lowest surface.

From this view of the subject then, it is evident, that the upper surface of the water attains to 212 degrees of heat, before the whole mass; and consequently steam will be generated on its upper surface, and evolate therefrom before the water boils; and by regulating the speed of impartation of heat, so that the whole mass may never attain to 212 degrees, the whole of the water in the vessel, may gradually be converted into steam of 212 degress of heat, and which process is called simmering.

The cause of ebullition then, does not consist in raising the temperature of water to 212 degrees; for if it did, it would occur on the upper surface, as soon as it attained to such heat. Nor does it consist in raising the whole mass to that temperature; for it is possible to raise it to that point, and there continue it without ebullition, provided the impartation of heat to the lower surface, is not more rapid than its egress from the upper.

The true cause of ebullition then, is to be attributed to the first raising the temperature of the whole mass of water in the vessel to 212 degrees, and to a continuance of the impartation of heat, more rapidly to the under surface, than it can escape from the upper; and the tumultuous motion of the water (termed boiling) is to be ascribed, to the rapidity of the transmission of heat, from the lower to the upper surface, and the rapidity of its escape therefrom, not being equal to the celerity of impartation.

The purport of boiling wort, is to coagulate a portion of the gluten, extracted by solution from the malt, and the period of continuance is regulated by the judgment of the brewer; and the purport of boiling hops in the wort, is to extract the bitter principle therefrom, and amalgamate it with the wort; both which is considered by some, to be better effected by boiling them in the wort, than by any other method; but on this subject there is a difference of opinion.

BREWER, *one who manufactures fermentable liquids.*

The art of brewing is unfortunately held in much too low estimation by some, because there are many persons that can brew very good beer, who have never received either a common, a scientific, or a literary education, and whose talents are not above mediocrity.

But such a view of the case is superficial, and not profound or just; for although such persons may be able frequently or generally to brew good beer, with plenty of good malt and hops, in suitable premises, and advantageous seasons of the year; yet admitting such to be their capability, they have been taught a practical system, which their own attainments in knowledge, or their natural talents would never have enabled them to discover.

They perform a practical chemical process, without the most distant knowledge of the rudiments of the science of chemistry; and which process probably was originally discovered by some able chemist, and transmitted to posterity with the accretion of improvements, resulting from the observation and experience of many in its course to the present period; and because an ignorant and unlettered person has become acquainted with the discoveries, and is able to imitate the operations of his learned and talented progenitors; it does not follow that the process of brewing is an unimportant art, and that knowledge and talent is not requisite to make a good brewer.

Not only was derived knowledge always necessary, or natural ability to add to the stock of information by new discoveries; but in the present day, the change in public opinion and taste, having led to the necessity of furnishing mild beer instead of aged, and perfectly transparent at all periods of the year, regardless of seasons and circumstances; the present race of brewers are required to possess not only all the stock of knowledge of their predecessors, but large demands are made on the science of chemistry and mechanism to furnish the means to gratify the fastidious taste of a never excusing public; and success is only to be measured, by a complete capability to comply with the demand.

Up to the present day it is the practice of some, to brew only at favorable seasons of the year; others (and some of extensive trade) omit from six to eight weeks of the hottest period of the year; but there are many, the nature of whose trade, and the extent of whose premises, require them to brew without intermission all the year through, and of whom the public require, without apology or excuse, beer of every description, that is sound, mild, and perfectly transparent, and such also, without intermission all the year through: and however unreasonable and tyrannical, public opinion may at first have appeared, and still does appear to those who cannot comply with the demand, yet there are a few brewers, who, urged by competition and necessity, have discovered the means to accomplish the task, and are therefore reaping the reward of public preference; and unless those who are yet unacquainted with the means, or who suffer their prejudices to stand in the way, or hesitate to make the necessary outlay of capital to accomplish it, or have not the means so to do, alter their system and adapt it to modern improvements, they must expect that their trade will necessarily languish and decay,

It is an adage and a very proper one, that "the best brewer is the one who can brew the best beer from the least quantity of malt and hops;" but it is not to be inferred therefrom, that any substitute for malt and hops is to be used,

The primary object of a brewer should be, to furnish his customers with beer that will give them satisfaction; and the secondary, to brew such beer at the least possible cost.

The conditions to effect the double purpose are, good materials to manufacture from; judgment, experience and skill to manufacture; and the facility of manufacturing at small current expenses; and it is the interest of every brewer to enquire, if it is possible to obtain better materials than he is accustomed to procure; if he can improve his system of brewing, and lessen his current expesnes.

The following are some of the enquiries, which he may perhaps advantageously make; and not merely apathetically enquire, but energetically endeavour to obtain satisfactory replies to, sparing neither pains, nor reasonable expense to acquire the needful information, and to put in practice that which may appear indubitably beneficial.

"Can I purchase better malt than I have been accustomed to do, or cause better to be made on my own premises than has heretofore been done?" "Can I purchase better hops, or devise, or find out a better method of preserving their quality, than I have been accustomed to do?" "Can I improve the quality of the water of the brewery, or procure better?" "Better prepare the malt for the mash tun?" "Take better mashing heats?" "Advantageously alter my process of extraction?" "Make any difference in the time of boiling?" "Alter my system of boiling?" "Improve my mode of fermentation?" "Adopt a better plan of racking?" "Simplify and better arrange my utensils and machinery, or make any other general alterations and improvements, calculated to save time and labour, diminish expenses, prevent waste, and cause a more systematic and profitable working of the whole?"

BREWHOUSE, *a house or place for brewing.*

Every brewery that is built and fitted up, should have for its architect, one who thoroughly understands both the theory and practice of the brewing business. For as a brewery may appropriately be termed, a brewing chemical laboratory; requiring to be fitted up on the best chemical and mechanical principles, so as to enable the brewer to furnish the best products at the least possible cost; therefore no one can so well judge and appreciate the proper adaptations of the brewery, as relates to its situation, its aspect, its internal arrangements, its required utensils and machinery, and their mode of fitting up and general arrangement, as the well informed and well experienced brewer.

Chemistry and mechanism therefore, are two branches of science, which every brewer should sedulously study, with a view to build and fit up on right principles, or to alter and improve that which is already built and fitted up, as the manufactory in which he has to labour; for it should ever be remembered, that for the production of good and cheap beer, good materials, suitable premises and machinery, with competent knowledge, skill, and experience are indispensably requisite.

In the construction and fitting up of a brewery, it is customary to imitate some building and its internal arrangements which takes the fancy of the projector or designer, as near as the scite chosen will admit, and circumstances allow; and thus error is propagated through prejudice, and want of knowledge and judgment. The prevailing principle on which they are built and fitted up, is for the purpose of getting through a brewing once in 24 hours; instead of being of a suitable extent and properly fitted up for brewing twice in an average of 12 hours, which it is possible to effect with facility.

To perceive the superfluous outlay of capital in the building and fitting up of breweries, which is usually expended; let us suppose that a person previously knowing that his trade will require the production of 100 quarters of malt per week, and he determines on building and fitting up a brewery, that will enable him to brew 20 quarters at a time, and thereby to accomplish the whole in five days, leaving him one clear day beside Sunday, for cleaning up, &c. and pursuing the ancient system of brewing, he occupies from 12 to 24 hours in getting through each brewing: while another person better versed in the science of chemistry and mechanism, and who has discovered a method of brewing better beer than his cotemporary, with a less number of utensils and subject to a better arrangement, and a system whereby he can get through two brewings in 12 hours all the year through, in hot weather as well as cold; and having also 100 quarters of malt to brew per week, and he determines on erecting and fitting up a 10 quarter brewery for the purpose; how very great must be the difference in the outlay of capital, to accomplish thc same purpose, which would be expended by the two individuals.

Independent of the superfluous outlay of capital, which often cripples the insufficient capitalist at the outset; and not only leaves him without resources for the advantageous conducting of his business, and perhaps involves him in debt before he has commenced; and if not, it cramps him at all events, in his capabilities of extending his trade by the purchase of public houses, &c. which would add to his profits; he has also to calculate on the superfluous interest on the unnecessary capital which is expended; and also the consequent increase in the current expenses of conducting business, such as the extra cost of fuel, labour, wear and tear, taxes, &c.

The first and most important consideration in the building and fitting up a brewery, is the suitable adaptation of the mechanical arrangements to accomplish the process of brewing in accordance with chemical requirements primarily, and secondarily, in conformity with the principles of rigid economy; and the following preliminary enquiries, previous to the fitting up a new brewery, or the alteration of an old one, should be made.

What is the best adapted machinery for preparing the malt for the mash tun, and other work required to be performed by such medium? The best description and situation of the utensils, in which to prepare the mashing menstruum? The most suitable method of furnishing the mash tun? The best form, situation, and material of the utensil in which to boil the wort? The most suitable receptacle for the wort after it is boiled and previous to its being cooled? The best description of refrigerator to cool it with? The proper size, form, and situation of the fermenting tuns and cleansing casks?

In dispensing with the use of cooling backs, not only may their cost be avoided, but also the cost of the building that contains them; and the chemical injury sustained, by too long an exposure of the wort to the atmosphere may be prevented; and the loss of wort by adhesion to their surface obviated; and although the cost of a refrigerator is to be set against the saving effected by dispensing with cooling backs, yet its cost will bear no comparison with the cost of those backs and the building required to contain them; and if the water which is used in cooling the wort is properly appropriated, and the value of the heat imparted to it computed by the amount of fuel which would be requisite to raise it to the acquired temperature; and if to such amount is also added, the value of the wort saved, which is usually lost by adhesion to the surface of the cooling backs, the annual saving in a brewery of moderate consumption would probably equal the cost of the refrigerator in one year, leaving all subsequent savings a clear gain. But it may be said that the room beneath the cooling backs, is usually appropriated to some useful purpose, and therefore the whole of the outlay for that building cannot be avoided. But in reply to such a statement, it may safely be asserted that by a judicious arrangement, in almost every brewery, as much building may be saved as contains the cooling backs, and that for the purposes which the room beneath is now appropriated, other room that is now frequently wasted may be used as an equivalent. And in illustration of the small space absolutely required for a brewery, the author can refer to a four quarter brewery now in use, and which has been used several years; in which 12 quarters of malt have been frequently brewed per week; the building and fitting up of which he furnished the plan for, which stands on ground admeasuring 22 feet by 14; consisting of basement and two floors, comprising cleansing room, tun room, brewery, counting house, grinding room, and malt and hop store.

CALORIC, *the scientific name for heat.* (See heat.)

CARBON, *the scientific name of one of the classes of ultimate principles or atoms, of which bodies are composed.*

Carbon is said to be found in a state of purity in the diamond only.

Carbon enters very largely into the composition of inflammable and fermentable bodies, and is diffused very extensively among bodies in general, and those bodies are comparatively very few, of which it does not form a component part.

CARBONIC ACID, *a compound of two classes of atoms, carbon and oxygen.*

One of the properties or characteristics of carbon as a class of atoms, may be termed anti-acidifiable; and of oxygen acidifiable; and the admixture of the two classes in certain proportions, is called carbonic acid; and in other proportions these two classes are mixed with other classes to a varied amount, and constitute various bodies, possessing diversified properties.

The properties of neutral salts and a variety of compound substances, may be termed a third or neutral property resulting from the blending of the adverse properties of carbon and oxygen.

Carbon enters largely into the composition of solid and quiescent bodies; and oxygen largely into the composition of fluid and gaseous bodies; both of which may be termed active bodies, being susceptible of easy motion, rapid transition, and extensive diffusion.

Fluid and gaseous bodies are large recipients of oxygen, and from the extensive diffusion to which they are subject, are admirably adapted to convey and distribute the oxygen which they receive, and to furnish oxygen by the decomposition of their own elements.

Thus barley is composed of several classes of atoms, of which carbon forms a conspicuous proportion in a quiescent state; and although the grain is furnished with all the functions of life, yet are they dormant, until impelled into action by the combination of extraneous oxygen derived from decomposed water and air, with the carbon of the seed; and from such period the principle of life progresses, by the continued impartation of oxygen to the grain, and abstraction from it.

The result of the combination of extraneous oxygen with the carbon of the seed is the formation of carbonic acid; and which compound would remain permanently fixed in the grain, but for the accretion of heat thereto, in sufficient quantity to convert it into carbonic acid gas of less specific gravity than the surrounding atmosphere, when its abstraction occurs by evolation.

The antiseptic properties of a variety of substances, are due to the presence of a large portion of carbon as a constituent class of atoms.

Carbonic acid exists in varied proportions in vegetables, and is also a component of wax, oil, gums, resins, &c.

The various chemical carbonates are compounds of carbon in excess, with some natural substance as the base.

CARBONIC ACID GAS, *an ærial product, resulting from the combination of heat with carbonic acid.*

The inspiration of carbonic acid gas occasions death.

It is twice as heavy as atmospheric air, at the same temperature, and occupies the lower strata when disengaged from bodies at the same temperature as the atmosphere; but it may be and often is rendered lighter than air, by its rarefaction resulting from the impartation of a sufficient quantity of heat; and bodies in a state of germination or fermentation supply the necessary quantity of heat to render the carbonic acid gaseous, by the liberation of latent heat within the body, consequent on its partial decomposition; and as the abstraction of carbon from the germinating or fermenting body, is necessary to facilitate and accomplish those atomic arrangements which are needful to the formation of new substances; so nature has wisely ordained the desire of the carbon and the oxygen to unite, the measures to effect it, and the means to accomplish the requisite transition.

Carbonic acid gas is a dangerous and destructive inmate of mines, wells, cellars, fermenting tuns, vats, &c.

It is also disengaged abundantly from charcoal in a state of ignition, which renders its combustion in close apartments dangerous and often fatal to life; and on all occasions prejudicial to health, when the carbonic acid gas disengaged, is mixed with the atmospheric air subject to animal respiration.

Carbonic acid gas will not support combustion; from the knowledge of which results the practice of discovering its presence in wells, brewer's vats, &c. by suspending to a line a lighted candle, which is let down to such a distance, as is sufficient to extinguish the light, in case carbonic acid gas is present, or to the bottom in case it continues to burn thus far; and without this preliminary test, no one should be allowed to descend into a well or vat that has recently been emptied.

In the calcination of chalk to convert it into lime, large volumes of carbonic acid gas are expelled from it, which gaseous product is formed by the union of the oxygen of the atmosphere with the carbon of the chalk, first forming carbonic acid; and next by the union of heat with the carbonic acid converting it into carbonic acid gas; and as the expulsion of carbon by such means is the work of art, and its reabsorption the work of nature; so lime rapidly absorbs a large quantity of carbonic acid gas, when placed within the sphere of its attractive influence; and lime is therefore found to be the most prompt and efficient medium of withdrawing such gas from wells, vats, &c. and which may be most advantageously effected by suspending fresh burnt lime in wicker baskets just above the surface of the water in the well, or very near the bottom of the vat.

In the malthouse and brewery, the production of carbonic acid gas as an excretory material is very great.

Carbonic acid gas furnishes to water, and the various vinous fluids, that sparkling appearance, and brisk and lively taste which is grateful to the eye and palate.

CASK, *a barrel, or wooden vessel used for liquor.*

Experience has proved, that oak is the most suitable description of wood for brewers' casks.

The sap of such wood which remains in it after it is cut, and from which the moisture is withdrawn, by an exposure of the wood to the desiccating effect of the atmosphere, is called tanin; and unless such material, which exists in a dry state, and is diffused throughout the veins or sap canals, is withdrawn from the internal superficies of the cask, to a depth to which the future liquor which it may contain may penetrate, such tanin as is dissolved by such liquor will impart to it an ill flavor, and color such as is colorless. It is usual therefore to endeavour to extract as much tanin from the cask previous to its use, as the beer or other fluid is capable of extracting; and a variety of methods are adopted for the purpose, such as burning the internal surface, which is a remedy as bad as the disease; repeated fillings with water, which proves a long and tedious process, and ineffectual for the reception of a more penetrating fluid; coating with lime which does not penetrate sufficiently deep into the pores of the wood; and various other inefficient methods; particularly for such casks as are used for spirits or vinegar; both which penetrate deep into the wood, and also possess a greater dissolving and extractive power.

The best adapted menstruum for the purpose is a cheap chemical fluid, which I have been accustomed to use for many years; for not only new casks and wood utensils of every description, but also as a disinfecting fluid for tainted casks and utensils, being possessed of powerful antiseptic properties and capable of penetrating the wood to any required depth; and it also possesses the property of neutralizing acid, and for its abstraction from casks and utensils it proves an excellent medium.

Good beer is much too frequently spoiled by being put into casks which are not in a fit state to receive it. This occurs frequently from negligence, but much oftener from inattention, and frequently from a want of a knowledge of the existence of a considerable quantity of acid in the wood of casks, which scalding water is not competent to extract; and which acid is frequently sufficient to cause an acetous fermentation in conjunction with the vinous. Although cleansing casks may be kept constantly in use under the most favorable circumstances, and be well scalded previous to each filling; yet are they liable to an accumulation of acid in the wood, particularly in hot weather, and which requires frequent extraction.

Sending out casks are yet more liable, in consequence of negligence, being often left uncorked and without bung for a long period, and frequently exposed to a hot sun and atmosphere, which rapidly acetifies the grounds that is left in them, and the beer which adheres to the surface and penetrates into the wood.

A constant and careful examination of every cask and the application of the necessary remedy to those that need it, should be entrusted to some confidential servant, on whom the responsibility should rest.

CELLAR, *a subterraneous place for stores or liquors.*

Every part of the premises of a brewer should be well adapted for the purpose for which it is intended; and the architect or designer should be a brewer who well understands the chemical requirements of the business as well as the mechanical.

It too often occurs, that the chemical requirements are altogether unattended to, in the construction and fitting up of a brewery; and those who are conversant with the subject, are often struck with the anomalous and inconsistent arrangements which they discover in passing through a brewery.

Thus for instance, a brewer who understands the chemical part of the process of brewing as well as the mechanical, knows full well, that the purpose of brewing store beer, is to obtain for it an aged flavor without acidity; and the production of a large amount of spirit, without experiencing its subsequent loss, by its conversion into acetous acid; or the loss of too much carbonic acid gas, in reducing its attenuation to such an amount, as will place it beyond the liability of experiencing a second fermentation after it is sent out; and also to furnish it for consumption in a state of perfect transparency; and knowing full well, that all these properties cannot be the product of the first or foul fermentation, and that what is left unfinished in the first, must be performed in the second or insensible fermentation, conducted under the most favorable circumstances; he naturally expects to find on a visit to a brewery, a vat room that is so situated, sheltered, and protected from the access of external heat, as to be nearly at a medium temperature all the year round, and in every respect suitable for the preservation of so valuable and extensive a stock as is often to be met with. But judge of his surprise, when he is ushered into a room, (perhaps with much complacency and pride) whose floor is upon a level with the earth's surface, and whose lofty summit is crowned with a tiled or slated roof, without an intervening floor or ceiling between it, and the top of the vats which are often parallel with the plate on which the roof rests.

He sees grandeur and magnificence in the display, but concludes that judgment and knowledge have had no share in the arrangement. He would find perhaps, as the author has found, that a thermometer placed on the top of the vats in summer in such a room, would indicate the atmospheric temperature at above 80 degrees, and another at the bottom, a little below 70 degrees; and the average temperature of the atmosphere surrounding those vats, about the proper heat of a vinegar maker's stove room; and in the winter, the atmosphere as much below the medium temperature, as in summer it is above: and probably the proprietor would be quite unconscious of the amount, or the difference in temperature in either case; and if conscious, perhaps not aware of the consequences.

In the choice of a situation for a subterraneous vat store room, (when circumstances will admit of choice) a dry chalky soil is much better than a damp argillaceous or gravelly soil, and due provision should be made for the admission of day light, a moderate supply of cool dry air without draught, and sufficient ventilation.

CHALK, *a white soft stone or substance, a species of earth.*

Chemists recognise two species of chalk, and denominate them sulphate of lime and carbonate of lime; the first imparting to water that flows through its fissures or over its bed, an acid, and thereby rendering it what is termed hard; and the latter carbonic acid, rendering it what is termed soft.

Many suppose, (not understanding the subject) that if a well is sunk in a chalk soil and water procured, it must be soft, and that consequently such water needs not the neutralization of its acid, because they are not aware, or have not the least idea that it can possess any; and year after year it is used, without the derivation of benefit from its improvement, because the need is not known or thought of.

Water containing acid, from whatever source derived, is not so good a solvent for the soluble extract of malt, and consequently is not so well adapted for the purpose of extraction, as water which contains none, neither as relates to the quantity or quality of the produce.

To use water containing acid, as a menstruum for the solution of malt extract, is to add to wort a measure of oxygen previous to its exposure to the atmosphere, from which it is at all times liable to receive a sufficiency for the purpose of a sound vinous fermentation; and at an unseasonable time of the year for brewing, and under negligent exposure of the wort for too long a period to the atmosphere, in which case it is liable to receive too much; and this previous and unnecessary addition, is but the aggravation of the evil of too great an impartation of oxygen from the atmosphere, the production of an extensive vino-acetous fermentation, and the consequent vapidity, thinness, and ultimate acidity of the product.

It is therefore one of the many necessary enquiries which a brewer should make, whether his water for the brewery contains acid, or any other adventitious substances, inimical to advantageous solution and fermentation; and if so, whether he can obtain better; and if not whether he can improve the quality of such as he is compelled to use.

CLARIFY, *to make clear or bright, to purify.*

The advance in civilization and the refinement of the present age, has been rapid, remarkable, and irrepressible; and is not only evinced in affairs of magnitude, but is discernible in matters of comparatively trivial import to society at large, but of serious consequences to those who have to cater for the gratification of the public taste. And among many who are affected by the change, from an indifferent regard to appearances to a fastidious taste to all that is unsightly, is the public brewer; who is imperatively required to furnish to his customers, at all times and seasons, and under all circumstances, a beverage that is not only perfectly mild and sound, but equally transparent.

Formerly the lower classes who were, and still are, the principal consumers of beer, thought it a mark of effeminate refinement to require a glass to drink their beer from; and however thick the fluid, it flowed from a pewter pot, with inexpressible zest down their callous throats, and all was well: but not so in the present day! Nothing less than a clear clean glass filled with ale of sparkling brilliancy will suffice for the lowest of the low: and so numerous are become the vendors, that as what cannot be obtained at one place, may be had at another. it becomes an imperative policy for the brewer to endeavour to furnish it at whatever may be the cost; or else he must submit to the penalty of public disesteem and loss pecuniary.

Formerly the brewer was required to furnish beer to the public at the age of one, two, and three years, which had naturally become bright in the cask, and not liable to subsequent opacity, the whole of its fermentable material being attenuated. But such beer will not now be commonly drank, and the brewer is required to brew all the year through, and to furnish it to the public at the end of a few days after brewing, perfectly mild, full, and transparent. Now to do this in hot weather, is certainly no easy task to the uninitiated; for as beer is required to drink what is called full in the mouth, which means that the brewer must leave plenty of fermentable matter unfermented in his beer at the time of consumption, to gratify the taste: and to effect this, he must check and control the first fermentation in the tun and cleansing casks, leave plenty of fermentable matter unattenuated, get his beer perfectly bright, and subdue the tendency to subsequent fermentation; which from the quantity of fermentable matter left, the excitation and oxygenation of a hot and sultry atmosphere, it is greatly liable to. But few are equal to this case of difficulty, and instead of bringing their beer to a proper state, to receive finings to clarify it; they endeavour to effect it by the use of an additional quantity; when instead of accomplishing the object, it does but increase its tendency to a second fermentation, for as it is customary to dissolve isinglass in stale beer to make such finings, the addition of such acid as it contains to the new beer, induces a second fermentation, of a fretting and acetous character, which never ceases in hot weather until the beer is too stale for consumption.

The rationale of the process of clarifying beer, is by the insertion of isinglass in a state of solution into the cask; and as the beer in which the isinglass is dissolved, has a greater affinity for the beer in the cask, than for the dissolved isinglass, it separates from it and leaves the dissolved isinglass suspended in the body of the beer, at or near its upper surface, in a flocculent form: and as there is an affinity between such isinglass and the gluten diffused throughout the beer, which causes its opacity; such gluten is attracted by the isinglass, and is drawn upward toward it from every remote portion of the beer; and when the whole is collected, the beer is transparent.

Should the combined isinglass and gluten be of greater specific gravity than the beer, the whole mass will sink to the bottom of the cask; but if not, or the carbonic acid generated at the bottom of the cask is continually ascending to the upper surface, the isinglass will remain suspended at the upper surface, or some intermediate distance between.

This effect occurs, provided the beer is not in a state of first or second fermentation; but if it is, the coagulation of gluten is still proceeding, and the creation of carbonic acid gas is still occurring; and the ascent of the latter from the bottom of the cask, and every portion of the body of the beer to the upper surface, keeps the gluten in a constant state of agitation, and prevents its union with the isinglass, and the descent of either to the bottom of the cask.

CLEANLINESS, *purity, freedom from dirt, &c.*

"Cleanliness is next to godliness," is an adage which appears to have become current, as the result of a knowledge of the divine command relative thereto, and from an observation of the effects of uncleanliness, inducing disease, pestilence and death.

A want of cleanliness carries with it its own peculiar punishment; and in the brewery it is soon and severely felt; for as wort and its products are liable to putrefactive fermentation, which nothing but great attention to cleanliness will prevent, the least departure from a systematic perseverance in it, will soon be productive of extensive mischief; as a putrefactive fermentation is a rapidly multiplying and extending operation.

The disease technically called "the fox," is the result of putrefactive fermentation; and to allow wort to remain by adhesion to the surface of vessels in hot weather, but a few hours comparatively speaking, involves the liability of a putrefactive fermentation, which will infect the vessel and every successive quantity of wort or beer that passes through it, until it is eradicated from the pores of the wood; for which purpose a strong and searching chemical fluid is necessary: and as prevention is much better than cure, and as prompt and frequent scalding of the utensils are not sufficient to prevent its occurrence at all times, the occasional application of such fluid with the habitual and prompt use of proper scaldings, will be found a certain preventative to the introduction of the disease.

"The fox," is often introduced into the brewery by medium of putrid yeast, with which the worts are pitched, resulting from the putrefactive fermentation of such yeast, occasioned by uncleanliness, or an improper mode of preserving it from one brewing to another; and a guile of beer once affected with the disease, will contaminate every vessel into which it enters, and a very small portion of it will impart to a large quantity of good beer its nauseous flavor.

CLEANSE, *to make clean, purify, clear away, &c.*

Fermentation is a process of reception, decomposition, rejection and recomposition.

Reception is first necessary to effect decomposition, and rejection subsequently to enable and facilitate recomposition.

A brewer's wort in the fermenting tun is a compound solution of gum, gluten, fecula, saccharum, &c.

The ultimate purpose of vinous fermentation is the production of spirit, and saccharum is the only substance which will furnish it; and a brewer's unfermented wort, does not contain so much saccharum as is needed, to produce the required quantity of spirit; and therefore it is necessary that a portion of the fecula should be converted into saccharum during the process; and in order to effect the conversion of fecula into saccharum and saccharum into spirit, there must be a decomposition and recomposition of the several substances previously existing; and the formation of new resident and fugitive substances; the residents are spirit and carbonic acid; and the fugitives, yeast and carbonic acid gas.

The receptive process of vinous fermentation consists in the wort receiving oxygen from the atmosphere, and yeast by the brewer's insertion. The oxygen which is received combines partly with the carbon of the wort to form carbonic acid and with the hydrogen to form spirit; and as the continuance of the carbonic acid in the wort would be inimical to the union of the oxygen with the hydrogen to form spirit, it is ejected from the wort by its conversion into gas; nature having wisely furnished the wort with the necessary materials for such conversion in the form of latent heat; which being liberated and set free by the separation of the atoms of carbon from their previous associate atoms, to unite with the visiting oxygen, such heat unites with the new formed compound; and as the atoms of heat are not ponderable, and the union with the carbonic acid increases the bulk of that compound, and thereby renders it specifically lighter than either the wort in which it is formed, or the surrounding atmosphere; it first rises to the surface of such wort, and then evolates therefrom a fugitive wandering through the air.

Yeast being a compound of coagulated gluten and carbonic acid gas, its reception by the wort appears to be necessary, to cause the commencement and continuation of the decomposing portion of the process of vinous fermentation, as the preliminary means of producing their own kind, agreeable to the established rule of nature; the existence of which it is much easier to perceive, than to comprehend the rationale of the operation.

The rejective part of the process of vinous fermentation, consists in the evolation of the carbonic acid gas from the surface of the wort, and the ejection of the yeast from the bung hole of the cask; or the mechanical removal of it from the upper surface in the tun, or its subsequent depuration to the bottom of the tun, if not mechanically removed from the upper surface; and by whatever method this evolation of carbonic acid gas, and the separation of the yeast is effected, it is a cleansing operation, as it consists in the removal of those excretory products of fermentation, which it is necessary to free it from.

But the technical term, "cleanse," as used in the brewery is applied to that mechanical operation, which consists in the removal of the wort in a state of fermentation, from the fermenting tun into several casks, which are called cleansing casks; in which it is allowed to continue until the first or foul fermentation is finished; and the propriety of the term "cleanse," as relates to the removal of the wort from the fermenting tun, is founded on its separation from the yeast floating on its surface, and that which has subsided to the bottom of the tun by depuration; and of the term "cleansing casks," is founded upon the facility which is furnished by such casks, accompanied by their occasional filling, for the separation of the yeast generated during the continuance of such fermentation.

The proper period for the removal of the wort from the fermenting tun into the cleansing casks, cannot be defined; as at such period it is subject to such a variety of circumstances and motives of which the judgment must take cognizance, and determine the proper time: and in addition to the separation of the wort from the yeast, which has been ejected from it in the fermenting tun, may be noticed, the purpose of dividing the bulk of wort into smaller bodies in a series of casks, to prevent the accumulation of too much heat during the process of fermentation; and the consequent too extensive attenuation of the wort on its cessation.

Much judgment is required in conducting the process of fermentation in the cleansing casks, as well as in the tun, and the utmost care and attention is requisite in choosing the proper time for filling up the cleansing casks, the state, temperature, and condition of the stillion beer, with which they are filled up, and that such filling up is not neglected at the proper period; and that a change from the stillion beer to other and suitable beer, should be made at a proper time, for the finishing off the process.

The principal objections to the usual method of filling up cleansing casks are, the return in cold weather of a large amount of stillion beer into the cleansing cask, which may have been much reduced in temperature in the stillion; and that such addition has the effect of checking and retarding both the fermentation and the separation of the yeast from the wort, both which operations need acceleration rather than retardation: again, during a great portion of the interval of the fillings up, the cleansing of the beer is much retarded by the difficulty with which the yeast can be ejected when the cask is not nearly full: further the labour and waste which it causes: next the night work which it occasions, the unpleasantness and danger of having men on the premises without superintendance, the liability of their neglecting the work, or doing it at an improper time and in an unsuitable way, and the cost of light, beer, &c.

To obviate all these objections, I have contrived a self acting cleansing cask, which is exceedingly simple, and of a trivial cost above the common cask; and which may be used in either way; and having used it for several years, with a close and attentive observation of the results of the fermentation, I can without hesitation or doubt recommend its adoption; and as no machinery is required to regulate the supply of wort, and it is kept constantly full without any manual aid, from the time of cleansing, until the need of fine beer to finish the process, I conceive the method to be truly valuable and superior to any other self acting system which I have ever seen beside.

COAGULATE, *to run into clots, flakes, curdle and congeal.*

The coagulation of a portion of the gluten extracted from the malt by infusion, is effected in boiling and fermenting the wort; and it is the practice of many, to form an estimate of the proper period for boiling wort, by the apparent extent of coagulation, as is evidenced by an examination of a small portion of the boiling wort in a glass, from time to time during the process.

The effect of boiling, is to coagulate the gluten in minute particles, which unite together by attraction; and upon repeated examination during the process, it will be found that the particles unite and form flakes, which continue to increase in magnitude; and when they have attained to a sufficient size in the brewer's estimation, he determines that the wort is sufficiently boiled.

The presence of gluten in wort is necessary to a vinous fermentation; but the quantity may be too small or too great for the production of a good result.

To obtain a solution and extraction of gluten from malt, to a definite and correct amount, for the ultimate purpose of correctly conducting fermentation, is a process unknown, and probably impossible to perform with any degree of accuracy; but the choice of correct mashing heats, and a proper mechanical method of extraction, are doubtlessly the best means to obtain a sufficient and not a superfluous quantity.

Nor are there any means to discover the quantity that is extracted and contained in a wort, other than by analysis, which method will not of course suit the brewer's purpose; and therefore it must be quite evident, that to be able to discover the proper period of boiling a wort, by an appearance of the quantity of coagulated gluten is a fallacy; for even could the quantity coagulated be correctly ascertained, yet that would afford no proof of the quantity left uncoagulated. A better criterion then is needed by those who trust to such an evidence, to determine the period of boiling their worts

To ensure a desirable fermentation, particularly in hot weather, the obtainment of an improper quantity of gluten by extraction in the mash tun, must be avoided as much as is possible; and the coagulation of a sufficient quantity of that which is unavoidably extracted should occur in the copper; and that which is coagulated by fermentation, should be well ejected and separated from the beer, previous to its consumption.

COAL, *a common fossil used as fuel.*

Coal is a combustible mineral dug out of the bowels of the earth, in which it exists in inexhaustible abundance; and appears to be the accumulated store of ages, reserved for the consumption of the modern and future race of beings, for whom no other adequate supply exists.

Coal is supposed to have been originally wood, which in the bowels of the earth, has in the lapse of time, undergone an organic change, still preserving its combustible properties, but having otherwise lost its arboreal characteristics. It is imagined, that in the early ages, previous to the extensive population of those countries where coal abounds, that forests after forests, unneeded for the past use of man, felled by the tempest and the tooth of time, have passed by the gradations of decay from a ligneous to a mineral state, so ordered and reserved by the all-wise dispenser of every good, as fuel for ages yet unborn.

The diversified properties of different species of wood, appear to have imparted to coal their varied characteristics.

Coal furnishes heat by combustion, which is appropriated to a variety of purposes by the ingenious contrivances of man; and a brilliant light, as a modern testimony of the increasing knowledge of the present age.

Coal not only serves as a most convenient and economical species of fuel, but in all its varieties, there is a suitable adaptation in every sort, to some peculiar mode and purpose of consumption; some sorts being superior for domestic use, others for the manufacturer's furnaces, the gas maker's retorts, the maltster's kiln, &c.

The products of coal in combustion, are, heat and light, aqueous vapour, gas, tar, ammoniacal liquor, oil, coke, soot, ashes, &c.

COHESION, *a state of union, a close connexion.*

All solid bodies are supposed to be composed of atoms, cohering together by the power of attraction of cohesion; and which are only separable by mechanical force, chemical affinity, and the impartation of heat.

The formation of a solid, is supposed to be effected, first by the existence of an affinity, or an innate desire in two atoms to unite, when placed within a certain distance of each other; and the possession also of a power to unite, when placed within the limits of that distance; which power is called attraction, and which increases in intensity in the inverse proportion of the square of the distance; and finally as the result of their union, in consequence of the exercise of the power of affinity and attraction. The two atoms thus united, not only possess a strong affinity for each other, which may be termed the cement of union; but they also possess an affinity for, and the power of attracting other atoms, that come within the range of their attractive sphere, and atom after atom are united to the pair, until by accretion a solid is created of limited extent: and on this principle, the natural formation of bodies is constantly occurring, as is evidently exhibited in the formation, growth, and maintenance of animate and inanimate bodies and substances.

Cohesion is effected chemically by those who understand this law of nature and imitate her operations: and mechanically by those who practically know how to effect it in numerous ways, without any knowledge of the theory of the system.

COLD, *not hot, the sensation resulting from the absence of a sufficiency of heat.*

To express the sensation which is felt, when a person feels uncomfortable, in consequence of the abstraction of too much heat, from any part or the whole of the body, it is usual to say, " I am cold," &c. instead of saying, "I am not sufficient-warm," &c. which latter mode of expression would be in accordance with the fact, whereas the other, implies the existence of a property or cause which does not exist.

The standard animal temperature of the human body is about 98 degrees; and in a variety of ways it may both receive and lose heat, but the effect of an impartation or abstraction, so as to raise or reduce the temperature of the body above or below that standard, is to make the body unpleasantly hot or cold, as it is usually termed.

Much heat is imparted to the body, by the decomposition of food, which enters into the stomach, as all substances in a state of decomposition liberate much latent heat, which in consequence of such decomposition becomes active.

Heat is also imparted externally to the body, when placed in the vicinity of substances possessing a greater quantity of heat than the body; which impartation is effected by transition. But the principal source of the supply of heat to the body is atmospheric air, which is inhaled in breathing, as described under the article " heat."

The absence of a sufficient quantity of heat, or the presence of too much in the malthouse or brewery, is productive of important consequences, if a suitable system of malting or brewing is not adopted to meet the resulting exigencies.

A medium temperature of the steeping water, of the working floors and of the atmosphere therein, and which is accessible thereto, is necessary to the conducting the malting process with facility and advantage; and any increase above, or decrease below a standard heat, is a departure from an advantageous point, proportionate to the extent of the deviation.

As germination progresses best at a medium temperature, when accompanied by concurring and propitious circumstances; the maltster finds when he is so favored, that his operations are rendered pleasant, easy, and profitable; but if his steep water, the room, or the air therein deviate altogether or in part, to a great extent from a medium temperature, his care, anxiety, watchfulness and labour are much increased in endeavouring to repress, or accelerate the growth of the grain committed to his care.

In the brewery a medium temperature is equally desirable, particularly in those rooms wherein the process of fermentation is conducted. The abstraction of heat from the utensils is unfavorable to the process of extraction. From water and wort—it causes the consumption of more fuel and occupation of time. From the atmosphere—it causes a more languid and difficult fermentation. The presence of much heat in the atmosphere, causes the absorption of too much oxygen by the wort, and too rapid and extensive a fermentation; and the extra labour, loss of time, breaking of the natural rest, and all the consequences of pitching worts at too high a temperature, to those who do not enjoy the great benefits conferred by a refrigerator.

COMBUSTION, ***burning, consuming by fire, &c.***

Every manufacturer should well understand the chemical and mechanical department of the process of his manufacture; as a comprehensive knowledge of each, may enable him to advantageously blend the benefits derivable from each, and to avoid an incongruous admixture, or natural collision, between chemical and mechanical improvements.

As an illustrative proof of the necessity and advantage of obtaining such knowledge, the method of imparting heat to a vinegar maker's stove room, may be referred to.

Comprehending the chemical process of acetification, and the natural process of combustion, he takes especial care to construct and fix his furnace exterior to the stove room, and to warm it with radicated heat from subjacent flues. And what is the inducement? He knows that the impartation of the oxygen of the atmosphere to his wort, is the cause of its acetification, and its ultimate conversion into vinegar; and he knows that the oxygen of the atmosphere is the cause of the combustion of the fuel in his stove; and consequently if he was to fix his stove within the room for the sake of mechanical convenience or economy, and allow the combustion of the fuel to be maintained by the oxygen of the atmosphere within the room, he would thereby deprive his wort of that necessary aliment of acetification.

This single proof therefore, among many that might be adduced relative to combustion, is quite sufficient to show, that before a mechanical improvement is determined upon, whether relating to combustion or any other subject, an enquiry should be made, as to what may be the resulting chemical effect.

If this enquiry was more frequently made, previous to expensive alterations, extensive additions, or costly erections being made, much unnecessary loss of capital, and the inculcation of injurious prejudice against improvements would be prevented.

It too frequently occurs, that the manufacturer does not study either the chemical or mechanical department of his business; and a machinist equally ignorant of chemistry, may offer him an improvement promising great economy; but for want of such knowledge, the injuries experienced may more than equal the expectation of benefit from its adoption; and soured in mind and temper, and lightened in pocket by such miscalled improvements, he in future indiscriminately rejects every offer that is made him and is thereby probably a loser of a real benefit through undiscerning prejudice.

The combustion of a substance may be spontaneous, commencing and continuing as the result of chemical combinations; such as phosphorus exposed to atmospheric air, as iron pyrites mixed with water and various other combinations: or combustion may be commenced and continued by friction; such as rubbing two pieces of wood violently together, &c.; and it may commence by placing one substance which is in a state of ignition with another that is not, the combustion of the latter resulting therefrom.

Calamitous conflagrations have frequently occurred from spontaneous combustion, and the combinations of such substances as are liable thereto, should be generally known, in order to induce the necessary caution to prevent such liabilities; and conflagration often results from the friction of machinery in the absence of lubricating materials.

But the principle of combustion commencing by ignition, and continuing until extinguished, or until the whole of the inflammable material of the substance is consumed, is that which should be universally known; as such knowledge is requisite to induce the necessary expedients to prevent and stay combustion, or to promote it, with a view to the benefit derivable from the heat evolved by the process.

As soon as a substance in a state of ignition, is applied to an inflammable body, it imparts to it heat and light, and the surrounding atmosphere imparts to it oxygen, which uniting with the atoms of carbon or hydrogen of such body or both, accompanied by the heat and light, a gaseous compound is immediately formed, and the united atoms evolate from the body whose combustion has thus commenced; and nothing more is needed for the continuance of such combustion, than a continued impartation of oxygen and light from the atmosphere to the consuming body, to create a new compound; and the combination therewith, of the liberated latent heat of the decomposing body and the atmosphere, to convert it into an evolating gaseous product; and thus by the continuation of this process of impartation of oxygen and light with the carbon and hydrogen of the body, and the liberation and combination of latent heat thereby rendered active, the process of combustion is gradually effected, and with a rapidity proportionate to the impartation of oxygen and light.

But it may be asked, if the subsequent impartation of oxygen and light to the inflammable body from the atmosphere, is sufficient to cause the continuance of combustion; why is not the same oxygen and light present in the atmosphere, sufficient to cause the continuance of combustion, without the necessity of the impartation of heat and light from the substance in a state of ignition? To which the reply is, that the constituent heat and light of atmospheric air, in its ordinary state, is not sufficiently great without concentration, to combine with the carbon and hydrogen of the inflammable body, together with the oxygen of the atmosphere, so as to form an evolating gaseous compound; and the constituent heat of the atmosphere and the inflammable body is latent, until the decomposition of either occurs; and being latent it is also resident, unless impelled to motion by the law of equal diffusion; and the atmosphere and the inflammable body, being probably of equal temperature or nearly so, there exists no incentive for the transition of a sufficient quantity of heat from the atmosphere to the inflammable body, to cause the commencement of its combustion; therefore to effect such a purpose, it requires the concentrated and active heat and light of a substance in a state of ignition, to convert the first products of the combination of the ponderable atoms of the atmosphere and the inflammable body into an evolating gaseous fluid.

The commencement of the combustion of inflammable bodies, may be effected by the concentration of the rays of heat and light as emitted from the sun, as is evidenced by the action of a concentrating lens.

In the combustion of fuel in a maltster's kiln furnace, a substance in a state of ignition is applied to such fuel, and its combustion commences, and is continued by the impartation of oxygen from the atmosphere. To ensure the continuance of such combustion, an unrestricted access of atmospheric air to the fuel in the furnace is allowed, through the intervening spaces between the furnace bars, on which the fuel is placed; and which air is decomposed, the oxygen and heat of air combining with the carbon and hydrogen of the fuel, which with the liberated heat of the fuel, forms carburetted hydrogen gas; and such gas being lighter than the atmospheric air contained in the kiln furnace room, and the kiln floor room, such gas, together with the nitrogen gas, resulting from the decomposition of the atmospheric air, which passed between the furnace bars, ascends, and passing through the perforated kiln floor, and the grain which is laid thereon, ultimately makes its exit by the cowel at the top of the kiln room, carrying with it a quantity of vapour from the grain, which is generated by the impartation of heat to the water which it contains, from the gaseous and ærial fluids which pass through it.

Although irrelative to the present subject, it may not be to the reader's wish, to explain the motive for leaving the front of the furnace open, during the combustion of the fuel therein, and the use of the side apertures, which may be oftener seen than the purport of it understood.

If the purport of desiccation, was the only motive for spreading malted grain on the kiln floor, it might be more economically and rapidly effected, by having an unperforated floor; but in addition to such purpose, three other and most important ones exist, which consist in the impartation of oxygen from the atmosphere to the grain on the floor, for the purpose of converting an additional portion of its fecula into saccharum, and the impartation of color and flavor which could not be effected on the malting floor; and as it is necessary that the atmospheric air should be highly heated to effect an impartation of the required oxygen, by a decomposition of such air, for such conjoint purposes; it is necessary that large volumes of air should pass through a perforated floor, and the grain upon it, and that it should be highly heated previous to such passage; and hence the necessity for allowing a free passage of air over the burning fuel, and through the apertures at the sides of the furnace to derive heat from such fuel direct, and by radiation from the plates forming the sides of the furnace.

In the combustion of fuel in a brewer's copper furnace, the same theory applies as relates to the combustion only, as is furnished relative to such as occurs in the maltster's kiln furnace; but the purport of the appropriation of the resulting heat, widely differs.

To the brewer's furnace, the access of atmospheric air through the space between the furnace bars, to cause the combustion of the fuel, is the same as to the maltster's furnace; but the brewer's purpose is to transmit as much of the heat furnished by the burning fuel as he possibly can, through the bottom and sides of the copper, to its containing water or wort; and all the heat generated, which he cannot succeed in imparting through such medium, is lost in its transit from the furnace to the end of the flue which surrounds the copper, by its escape into, and its exit from the chimney.

The loss of heat in the combustion of fuel, is in almost every manufactory very great, either from the rapidity of the transition of the gaseous products of combustion, which are the conveying medium of heat from the burning fuel to the chimney's top, preventing the transfer of the whole of the intended receptive body; or by radiation from the various substances, which receive a portion of that which is evolved from the fuel in combustion: and to prevent the loss of such heat to the greatest possible extent, much mechanical ingenuity has been put into requisition, and with much advantageous effect by many who well understand the subject of combustion, the radiation of heat, &c.

CONDENSE, ***thick, close, dense, contracted, diminished in bulk.***

Condensation may be effected in a variety of ways; by abstraction, combination, compression, &c.

The condensation of an aqueous vapour may be effected, by the abstraction of a portion of its heat, sufficient to reduce it to a fluid.

An aqueous vapour is formed from a fluid, by the impartation to that fluid of more heat than is sufficient to raise its temperature to 212 degrees.

The effect of such impartation is to separate the ponderable atoms of which such fluid is composed, to a greater distance from each other; and as such atoms (and all the ponderable atoms of which bodies are composed) are subject to the law of gravity; and the atoms of caloric are subject to the laws of recession and equal diffusion; the former having a tendency to fall toward the centre of the earth, and the latter primarily to recede from it, and secondarily to move in every direction where needed to restore an equality of diffusion; the specific gravity of that portion of the fluid to which the extra quantity of heat is imparted, is rendered less than the superincumbent atmosphere, and consequently it rises and leaves the upper surface of the fluid, and floats in the atmosphere.

To condense such vapour, and restore it to its original state —a fluid; nothing more is necessary than to abstract by natural or mechanical means, as much heat as was imparted to it over and above 212 degrees.

This process we may daily see effected in a variety of ways; such as the abstraction of heat from aqueous vapour, by the atmosphere in which it floats, causing its condensation and precipitation to the earth in mist, rain, snow, or hail.

The abstraction of heat from aqueous vapour in the cylinder or other apparatus of the steam engine, by the injection of cold water, &c. and its consequent condensation and conversion into water, is another illustrative method.

The abstraction of heat from alcoholic vapour, in a variety of ways in the process of distillation, effects its condensation and conversion into liquid spirit.

The condensation of many fluids occur by combination or admixture; and among the many illustrative examples that might be adduced, the condensation of spirit and water when mixed together, may be referred to as sufficient.

The admixture of one gallon of spirit, and one gallon of water together, will not produce two gallons of the mixed fluid; and if both were of an equal or unequal thermometric temperature previous to the admixture, the compound fluid will be found to have much increased in temperature by the admixture, and such increase in temperature is the result of condensation; for as the spirit and water chemically unite, both bodies are necessarily decomposed, and the recomposition of a new body occurs; and by such decomposition a portion of the latent heat of the two bodies is liberated and rendered active; which circumstance is sufficient to account for both the condensation and the increase in the thermometric heat; inasmuch as the latent heat which is rendered active is no longer a constituent of the two bodies; and by its transition to the air, to the mercury in the thermometer tube, or to any other substance, the bulk of the compound is necessarily diminished in the ratio of the amount of heat lost.

Condensation by compression may be effected in a variety of ways, and upon a variety of substances; such as the compression of air in the barrel of an air gun, of hops in a press, &c.

In the compression of air in the barrel of an air gun, a portion of the latent heat of air, is forced by pressure through the metallic tube, and is thereby rendered active; as is evidenced by the heat of the barrel, which increases in temperature in the ratio of the extent of the condensation effected, and the rapidity of the abstraction of heat from the external surface, by the surrounding atmosphere: and thus the bulk is diminished, by an expulsion of a portion of the constituent atoms from the air, and consequently the remaining atoms are pressed closer together, and occupy a smaller space than before. On releasing the condensed air from the barrel of the gun, as much heat as had been expelled during the condensation instantly unites with it, and restoration to its former bulk immediately ensues; and this property of parting with a portion of its latent heat by condensation, and the instant recovery of an equal quantity from the surrounding atmosphere, upon its liberation from the barrel of the gun, is called elasticity. And this property of elasticity possessed by atmospheric air, goes far we conceive, to prove the correctness of the theory furnished, that heat is composed of solid atoms possessing the power of recession from the centre of the earth as a primary law, and consequently are imponderable; possessing also the power of equal diffusion as a secondary law, and consequently are every where present; smaller also than ponderable atoms, and sufficiently small as to be capable of passing through the interstices presented by the union of the ponderable atoms, constituting solid bodies by attraction of cohesion; and consequently, as per this and other examples, the whole of the constituent atoms of air being submitted to pressure, and the atoms of heat forming a part of the compound, being alone sufficiently small to pass through the interstices presented by the union of the spherical and ponderable atoms, of which the metal of the gun barrel is composed, they only are expelled in the process of condensation of air, effected in such barrel.

CONSUME, *to spend, destroy, waste, lessen.*

To obtain to the utmost extent of capability, and to waste nothing beyond the bounds of possibility, should be maxims well observed in every manufactory: and that they are not in many breweries is a matter of reproach to the brewer, the general superintendant, or the principal.

Few brewers, compared with the total number, obtain so much extract from malt as they ought to do; and many even of those that do, waste much more than there is any occasion for, after they have obtained it; and they merit reproach, because when offered information for a moderate premium, how to effect both purposes, they will not assure themselves by enquiry whether or not the offer is worthy of their acceptance, and if the correctness of the information may be relied on; nor will they compute its value, or (as the adage terms it) "give a sprat to catch a whale."

To point out the cause of the non-obtainment of as much extract from malt as is possible by many, and its subsequent waste, without furnishing the mode by which more might be obtained and less lost; (which it is not the purport of this work to do) it is sufficient to say, that the causes are, an improper method of preparing the malt for infusion, the selection of improper mashing heats, the appropriation of an improper time to mashing, to subsequent solution, &c. and an improper mechanical method of effecting it: and as relates to waste of extract; by the use of unnecessary utensils, and the consequent loss of extract by adhesion to them; and loss by other means in its transit from the mash tun, progressively to the cask of consumption, as beer.

Nor is the term "unnecessary waste," to be confined to the waste of extract alone: the waste of fuel, labour, time, interest of money, and in current expenses, form an aggregate amount of loss in many establishments, which if but known, would be deemed a sufficient remunerating profit by many.

To consume, chemically speaking, is to destroy a body, as relates to its indentity, but not as to its ultimate principles, or the atoms of which it is composed, and which are supposed to be indestructible: thus coals are said to be consumed, when submitted to the process of combustion; by which operation the original body is decomposed, and its constituent atoms distributed in various directions, to enter into new combinations with other bodies.

DECOMPOSITION, *a decompounding, a disuniting, or separating of parts.*

All bodies are subject to decomposition by chemical or mechanical means, and may be divided into substances, and subdivided into the ultimate principles or classes of atoms of which they are composed. This division and subdivision is ever occurring naturally. Nature may be said to be a profound chemist, ever at work in her vast laboratory; commanding indestructible atoms to unite and disunite, and moulding them into an infinite variety of forms, and imparting to such forms innumerable properties.

By the chemical decomposition of bodies, man is enabled to imitate nature in a variety of ways, to appropriate to his use the constituent products, and to form new substances and compounds: and by mechanical decomposition, he is enabled to convert the works of nature into an endless variety of products, to minister to the necessities, the comforts, and the luxurious use of all mankind.

The process of malting includes the decomposition of a portion of the internal constituent substances of the grain, of the water imbibed in the process of steeping, and the atmosphere which surrounds it.

Such decomposition is caused by an affinity which exists between a portion of the atoms of which the grain and water is composed, by the power of mutual attraction, and their consequent union, which causes a commencement of decomposition, and which is subsequently continued by the affinity subsisting between the atoms of the grain and of atmospheric air; their mutual attraction and consequent union.

In brewing, a mechanical decomposition of the malt is effected by grinding or crushing, and a chemical by solution. The resulting wort is also subject to a chemical decomposition by an affinity and attraction subsisting between the atoms of such wort and the surrounding atmosphere.

Under the heads of malting and fermentation, the subject will be more fully discussed.

DENSITY, *closeness, compactness.*

With the term density, may be appropriately connected the term specific gravity, for although they do not express the same meaning, yet the more dense a body is, the more is its specific gravity; and so intimate is the connexion, that it is a common practice with many brewers, to state the indications of density, as of specific gravity.

From the term density we are to understand, that if two bodies are of an equal size, and one weighs heavier than the other, that the heaviest is composed of the greatest number of ponderable atoms, and consequently they are more densely or closely united.

The first operation in the process of brewing, is to obtain as large a quantity of extract from malt by solution as is possible. This is effected by steeping ground or crushed malt in hot water, the soluble parts of which are thereby dissolved and diffused throughout the water, forming a new compound called wort.

To ascertain the quantity of extract obtained, and to regulate the quantity that shall pervade a barrel of water, for the purpose of sale at a definite price, an instrument called a saccharometer has been invented; and by an accompanying rule, the density and the specific gravity of such wort is denoted; also the quantity of dry extract which is contained in a barrel of 36 gallons, or in 100 gallons of such wort, which would be found if its evaporation to a state of dryness was effected; and also the quantity of proof spirit which 100 gallons of such wort would yield by distillation after its fermentation, if attenuated to the density or specific gravity of water.

Water will hold in solution many substances to a varying yet limited extent, without any increase in its bulk, provided a chemical combination between the water and the substance added occurs; when in such case, as much latent heat is liberated, as occupied a space equal in bulk to the substance added, and being rendered active evolves from the compound in consequence of the decomposition of the water and the substance, and the formation of the compound wort; and it is this liberation of latent heat, and the resulting activity of such heat, that occasions the increase in the thermometric heat which occurs in compounds upon their formation, whose mean bulk is not equal to the bulk of the separate substances, previous to their admixture.

Thus a barrel of water weighing 360 pounds at 62 degrees of heat, will hold in solution 20 pounds of dry extract of malt without any increase of its bulk; and the compound (which may then be termed wort) will weigh 380 pounds: hence it is evident that by the admixture, 380 pounds of ponderable atoms form a constituent portion of the compound, and which occupy no greater space than the 360 pounds of ponderable atoms, which form a constituent portion of the barrel of water; and consequently, that the ponderable atoms of the compound fluid (wort) are more closely compacted, than are the ponderable atoms of the simple fluid (water).

The data on which Dicas's saccharometer is calculated, is the assumption as a fact, that an imperial barrel of water weighing 360 pounds, will hold in solution 20 pounds of dry extract of malt, without any increase in bulk; and that all additions beyond that amount will increase its bulk; and hence it is inferred, that any additional quantity of extract dissolved in such water, will displace as many pounds of water as is the weight of the extract inserted.

Now by this rule, if 50 pounds of dry extract of malt were added to a barrel of water, 30 pounds of that water would be displaced; and although the total quantity of water and extract together would weigh 410 pounds, yet one barrel of the wort will weigh only 380 pounds; yet Dicas's saccharometer indicates, that the density of such wort is 50 pounds per barrel, because a barrel of wort, which by scale weight weighs 380 pounds, he assumes to have required 50 pounds of malt extract, to impart to it such a weight. But several other saccharometers such as Richardson's, Long's, Dring and Fage's, &c. indicate how many pounds a barrel of wort will weigh more than a barrel of water by scale weight; and a barrel of wort that weighs 380 pounds in the scale, is said to be of 20 pounds density by such saccharometers, instead of 50 pounds as by Dicas's; so that two and a half pounds by Dicas's instrument, indicate one pound by the saccharometer of either of the other party, with the exception of a trivial discrepancy in the indication of each.

As the use of the saccharometer is designed to indicate the produce of any given quantity of malt, in order that a brewer may judge of its quality, by comparing the products of one brewing with another, or by any fixed standard of his own creation; and to regulate the strength of his worts, conformable to the various prices which he intends to sell his beer for; it is but of little consequence which saccharometer he uses as relates to either purpose; but if he reads a Treatise on Brewing, or other work, wherein the author states, that by his own or any particular system of brewing, that he obtains so many pounds density, or pounds specific gravity from a quarter of malt, and he is desirous to know if by his own system he obtains so much, it is not only necessary to know by whose saccharometer the amount stated to be obtained was indicated by, but he should also know the relative indications of such saccharometer, to the one he uses.

DISSOLVE, *to melt, separate, break up, destroy.*

A variety of solid bodies may be dissolved by the impartation of heat in what is termed a dry state, and be converted into fluids or gases; or by the impartation of heat by medium of a fluid, the solid body being immersed in the fluid; or by an affinity existing between the atoms of which a body is composed, and the atoms of an ærial or liquid fluid in which such body may be placed.

To dissolve by what is termed dry heat, (which means the impartation of heat, without the agency of a liquid fluid) or by what is termed moist heat, (which means the impartation of heat through the medium of a liquid fluid) the action of the heat upon the solid, destroys or overpowers the attraction of cohesion, by which the atoms of such body were held closely united, and separating them one from the other, enables them to move freely among each other, which freedom of motion, is necessary to the constitution of a liquid or ærial fluid.

To dissolve by chemical action, or in other words, by affinity and attraction, is to place a solid in a fluid or vapour, whose composition is of such a species of atoms, as have a strong affinity for the atoms of which the solid is composed; by which means the preceding union of atoms is dissolved, a fresh union takes place, and a new compound is created.

But some solids require the mechanical impartation of heat, to aid the chemical action of affinity and attraction to effect their dissolution; and such is the case with the soluble materials of malt which not only require the impartation of heat by medium of the menstruum employed, but a correct quantity to effect a productive and advantageous solution.

Malt is a compound of substances possessing different properties, and a brewer's object should be to dissolve a right proportion of each; but if he adopts too high or too low a temperature of the mashing menstruum, his purpose will be defeated, coagulation occurring instead of solution. The choice of a right heat therefore is not only necessary as relates to the prevention of such an evil (technically called setting the goods) but also for the obtainment of as large a quantity of extract by solution as is possible, and a proportionate amount of the several substances, as is requisite to produce the best final result.

The puport of the impartation of heat in the solution of the soluble substances of malt, appears to be, to overpower the attraction of cohesion, by which the ponderable atoms composing such substances are held together, and to separate them to such a distance from each other, as is necessary to render them free to enter into chemical combination with the atoms of which the water is composed: heat therefore acts mechanically, to facilitate the chemical action of affinity and attraction.

DISTIL, *to drop, flow or run gently, to use a still.*

Any compound fluid that can be subjected to the vinous fermentation is capable of producing spirit; and the spirit generated by such fermentation, may be separated from the fermented fluid by distillation.

Although the spirit generated in fermentation is diffused throughout the fermented fluid, and ultimately blended with it by chemical admixture, yet it is easily separated from it by the agency of heat.

The facility of separation is owing to the circumstance, that spirit boils or is converted into vapour, at a much lower thermometric temperature than water, the boiling temperature of spirit being 176, and water 212 degrees, by Farenheit's thermometer.

The relative specific gravity of alcohol to water, indicates that an equal bulk of the former, is composed of less ponderable and more imponderable atoms than the latter; and as the power of either to ascend in the superincumbent atmosphere, is in the ratio of the relative specific gravity of each to such atmosphere; so alcohol being specifically lighter than water, requires the impartation of the least amount of heat to it, to render it of the same or less specific gravity than the atmosphere; and consequently its evaporating thermometric temperature is lower than the evaporating thermometric temperature of water.

On the supposition that the intensity of the power of gravity to which the ponderable atoms of which alcohol is composed, are subject, is precisely the same as that to which the ponderable atoms of water are subject, then the amount of the latent and active imponderable atoms of alcohol at an evaporating temperature, must be the same, as the united amount of the latent and active imponderable atoms of water, at its evaporating temperature.

The fermented fluid usually submitted to the process of distillation, may be divided into alcohol, water, oil, and the extract of the vegetable substance, which has not been decomposed by fermentation.

The impartation of heat to such a fluid in sufficient quantity, to raise the temperature of its upper surface to 176 degrees, will convert all the spirit at such surface, or in its immediate vicinity into an alcoholic vapour, which will leave the fluid, and rise in the atmosphere or head of the still. If all the spirit contained in the fluid was situated at, or near the upper surface, the whole of it would be evaporated without the accompaniment of any, or but little aqueous vapour. But as the spirit is equally diffused throughout the whole body of the fluid, and cannot instantly rise to the upper surface, and as the heat imparted does instantly rise to the upper surface, so there is the liability and the almost certainty of the upper surface of the water being raised in temperature to 212 degrees, before the whole of the spirit is evaporated; and if such is the case, aqueous vapour must rise with the alcoholic, and in quantity proportionate to the rapidity of the impartation of heat. There is also the liability by the too rapid impartation of heat, to cause the oil near the upper surface to be converted into vapour, and to rise with the alcoholic and aqueous vapours.

If the purport of the operator is to separate, collect, and condense the alcoholic vapour, as free as is possible from the aqueous and oleaginous; he must impart heat to the fermented fluid very slowly, and in no greater quantity than is sufficient to raise the temperature of its surface to 176 degrees; but the difficulty or impossibility of maintaining the precise temperature in common practice, must preclude the possibility of separating the spirit in purity by the common still, or any improved still without the aid of chemical agency, and a second or third distillation.

In business distillation, the main purpose of the distiller is or should be, to bring over the whole of the spirit which his wash contains, as free as is possible from aqueous or oleaginous vapours; or in other words of the greatest possible purity and strength, and as economically as he can, as relates to the cost of fuel, labour, time, &c.

A correct scientific knowledge of the subject of distillation, must enable the theoretical and practical distiller to perceive, that the ancient crane neck still or the alembic, are very incompetent to bring over a strong or pure spirit from wash, from the causes already stated; and however slow the process may be conducted, much aqueous and oleaginous vapour will rise with the alcoholic, particularly at the latter part of the process, when from a desire to obtain the whole of the spirit the wash contains, the distillation of the wash is continued until the whole is brought over. The produce of the latter part of the process is not allowed to mix with the proof spirit, but is run off by itself, and is denominated faints. Another and a very considerable defect in the crane neck still and the alembic is, that as so much aqueous vapour rises with the alcoholic, the spent wash becomes very dense, and is liable to burn at the bottom of the still, and give to the spirit an empyreumatic smell and flavor, unless it is kept in a constant state of agitation toward the latter part of the process; to effect which, a suitable apparatus and the requisite power to keep it in constant motion is necessary, adding to the process a considerable expense for power, wear and tear, labour, &c.

The obtainment of such a knowledge, has induced the invention of various descriptions of stills, to obviate the difficulties and disadvantages attendant on the use of the crane neck still and the alembic; each possessing considerable merit, and being decided improvements on the ancient utensils used for the purpose of distillation.

The author of this work, is also the inventor of one, which he has designed should be an improvement on all others extant; but as his opinion of its merits may be more favorable than is consistent, he must leave the decision to others, whom he refers to the article "Still," for particulars relative to its capabilities.

EFFERVESCE, *to grow hot by fermentation, the effect resulting from the creation of carbonic acid gas.*

To cause the effervescence of a vinous fermented fluid, if it contains any acid, it is sufficient to add some carbonate to it, which will cause the production of carbonic acid; and the decomposition of the acetous acid, and the carbonated substance, will cause the liberation of a considerable quantity of latent heat, and which becoming active unites with the carbonic acid, and converts it into carbonic acid gas; and the gas created throughout every portion of the fluid, rushes with great rapidity to its upper surface, and thereby a portion of the fluid is converted into bubbles distended by the gas, which on their arrival at the upper surface burst, and liberate the enclosed gas, and the resulting circumstances and appearances are denominated effervescence.

To cause the effervescence of such fluid naturally, and without the addition of any carbonate, it is sufficient to confine a fermentable fluid, which has not undergone the process of vinous fermentation to the full extent of its capability, in a strong vessel and tightly close it; and by placing such vessel in atmospheric air of sufficient temperature to promote fermentation, such process will soon commence, producing carbonic acid gas, by the transition of oxygen from the atmosphere through the material of the vessel, or the substance which closes its aperture, and which unites with the carbon of the fluid thereby forming carbonic acid; a partial decomposition of such fluid consequently ensues and liberates latent heat, such heat is thereby rendered active, and uniting with the carbonic acid converts it into carbonic acid gas, and such gas being forcibly retained in the vessel, accumulates, and when the aperture is opened, the gas rushes with great velocity to the aperture, converting the fluid into innumerable bubbles distended by the gas, and which in the receiving vessel presents those appearances denominated effervescence, and to an amount proportionate to the quantity of carbonic acid gas generated.

EJECTION, *the act of casting out, expulsion, voidance.*

The study of the works of nature, impart those higher sensations of pleasure to the mind, which wonder, astonishment, and the admiration of stupendous and skilful operations ever yield.

To note her performances in the process of decomposition and recomposition, and the mode by which she effects the ejection of the superfluous materials, as relates to the composition of the new compound, is to observe that which is pleasingly and admirably illustrative of the wisdom of that being who has planned, contrived and directed the skilful operation, of whom nature is but an ideal type, conceived and so denominated for the facility of common converse.

To cite but one process indicative of such method of ejection, as sufficient for the purpose, let us look at a fluid in a state of vinous fermentation. The compound called wort, consisting of water and the soluble materials of malt, is the best adapted for our consideration, as relates to the purport of this work.

If the grain which is usually submitted to the process of malting for the purpose of effecting a change in the constituent principles of its composition, for the ultimate purpose of manufacturing beer, was fit for no other appropriation whatever, we might perhaps be tempted to ask the question, why should there be any materials in the grain, which are not necessary for the formation of such a compound? and be inclined to question the consummate wisdom of the author of the arrangement: but what would be the doubt is now the confirmation; and the confirmation is the more strongly confirmed, when we consider and know the various important purposes, to which one species of grain may be applied without any collision of principle, or change of the universal laws, which govern the infinite variety of transmutations to which all bodies are subject.

In the conversion of grain into malt, the excretory atoms are carbon, and nature avails herself of the affinity existing between the carbon of the grain and the oxygen of water and air, to effect an ejection of the surplus quantity from the grain, in the form of carbonic acid gas, which if allowed to remain would impede the formation of saccharum, which is the purport of her work. The result of such affinity between the carbon and the oxygen, is their union by attraction and the formation of carbonic acid. But the formation of carbonic acid as the final measure is not her purpose; but her object is the removal and ejection of the superfluous carbon of the grain, and the following is the method by which it is accomplished. The affinity and attraction between the carbon and the oxygen being mutual, each recede from their situation in order to meet, and thus set at liberty the atoms of heat, which were previously contained within the interstices resulting from the spherical form, and the adhesion of the atoms of carbon to its associate atoms in the body of the grain, and such atoms of heat being rendered active unite with the carbon and oxygen, and thereby form carbonic acid gas, of less specific gravity than the surrounding atmosphere; and the ejection of the carbon in this state of combination, is effected through the husk, and the gaseous fugitives become the tenants of the air. But it may here be asked, why was not the same heat sufficient to remove the carbon alone, without the necessity of the visitation and union of the oxygen of the air with it? To which enquiry the reply is, because the atoms of carbon in the grain were united to other atoms by attraction of cohesion; and which the atoms of heat within the interstices were not able to overpower; and that to overcome such force, the more powerful force of affinity and attraction, existing between the atoms of the carbon of the grain, and the oxygen of the water and air, were necessary to overcome the weaker affinity and attraction of cohesion, subsisting between such carbon and its associate atoms in the body of the grain.

In the vinous fermentation of wort, the ejection of the solid material called yeast, and the gaseous product called carbonic acid gas is necessary.

The ultimate intent of vinous fermentation, is the creation of spirit as a primary measure, and carbonic acid as a subsidiary.

The excretory materials are carbonic acid gas, and coagulated gluten.

The affinity existing between the oxygen of the air and the carbon of the wort, cause their union on precisely the same principles as in the body of grain in the process of germination: the same liberation of latent heat, the same conversion of carbonic acid into gas, and the similar escape of such gas from the surface of the wort.

The gluten extracted from the malt, is intimately blended with, and diffused throughout the whole body of the wort.

The decomposition of such wort causes the particles of gluten to unite by attraction of aggregation in flocculent masses, which are carried from the interior of the wort to its surface by the carbonic acid; a portion of which gas combines with the gluten, which forms vesicles inflated by such gas, and which in such state of combination is called yeast. Thus we perceive, that the process of vinous fermentation proceeds first, by the transition of oxygen from the atmosphere to the body of the wort to combine with its carbon, effected by the agency of affinity and attraction. Second, by the removal of the carbon from its position, being influenced by the attraction of the oxygen. Third, by the liberation of the atoms of latent heat which were contained in the interstices, resulting from the union of the spherical atoms of which the wort is composed, by the removal of the carbon from its position. Fourth, by the union of such heat with the carbonic acid newly formed, and by its addition, converting it into carbonic acid gas. Fifth, by the coagulation of the gluten, forming one of the component substances of the wort, by the union of the molecules of coagulated gluten by attraction of aggregation, and their formation into flocculent masses. Sixth, by the inflation of the vesicles formed by such gluten with carbonic acid gas, and thereby forming yeast. Seventh, by the mechanical ejection of such gluten or yeast by the carbonic acid gas, which rising with rapidity from the interior of the wort, carries the gluten to the upper surface, from which if not removed by skimming from the surface of the tun, or by ejection from the bung hole of the cask, the imprisoned carbonic acid gas will soon burst the vesicles that contain it, and when the fermentative action ceases, and the carbonic acid gas is ejected from the wort, the yeast will fall through it, from the upper to the lower surface, from which the wort may be withdrawn.

ELECTRICITY, *attraction without magnetism.*

The above meaning of the term as furnished by the dictionary, is as unmeaning, indefinite, and unsatisfactory, as it could possibly be expressed, and evinces the fact, that the compiler not being able to give a positive meaning, gave what may be termed a negative one. But the author of this work, is no better able than the compiler of the dictionary, to furnish a positive or satisfactory elucidation of what electricity really is, nor is he aware that any one has made the indubitable discovery: but he can do as many others have done; he can furnish an hypothesis, or as some would term it a fanciful theory, and be perhaps as near the truth as many others. He is of opinion that the electric fluid is a compound composed of oxygen, hydrogen and caloric. That the electric fluid which pervades the atmosphere, is diffused throughout it (for illustration's sake) like veins in marble, in all directions.

That the supply of oxygen is by an emanation from trees, herbs, &c. in a state of vegetation; and the supply of hydrogen from stagnant pools, marshes, &c. That the cause of the abundant supply of both is caloric. That the combination of oxygen and hydrogen in certain and correct proportions to constitute an explosive electric fluid, is necessary, and that the admixture of a definite and sufficient quantity of caloric with it is needful to cause the explosion spontaneously.

In support of such theory, he refers to the facts, that the electric fluid is most abundantly diffused throughout the atmosphere during the months of spring and summer, and that but little is present in autumn and winter. That every thing in a state of vegetation furnishes large quantities of oxygen to the atmosphere by transpiration during the day, and more profusely, when under the influence of heat emanating from an unclouded sun, the acceleration of the circulation and decomposition of the sap being thereby promoted. That all substances subject to a putrefactive decomposition furnish large quantities of hydrogen to the atmosphere; and that such decomposition is highly promoted and facilitated by heat; and the exhalations from stagnant water, marshes, pools, cesspools, &c. that precede a thunder storm, furnish one of the component parts (the hydrogen) of the inflammable fluid. That a chemical admixture of certain proportions of oxygen and hydrogen gases, form a spontaneously explosive compound, which admixture occurs in the atmosphere, induced by the affinity and attraction existing between the atoms of the two gases. That the destruction of trees by the electric fluid being of more frequent occurrence than other substances, implies the probability of a connexion of the oxygen emanating from their leaves with the electric fluid, and forming part of the inflammable train, which spontaneously igniting in such part where the admixture of the two gases in right proportions is complete, the explosion and consequent destruction of every object connected with the train is effected. And that the mazy and forked appearance of lightning, denotes its vein-like diffusion throughout the atmosphere.

Whatever may be the cause of the formation of the electric fluid, the materials of its composition, the laws by which it is governed, or whether in identity the electric, magnetic, and galvanic fluids are the same, or that they may differ by some modification of the proportions of the classes of atoms of which they are composed, are subjects of enquiry, in which the brewer is not so much interested, as in the effects resulting therefrom; because in hot weather, he is frequently liable to sustain much injury therefrom.

How or in what way, the spontaneous ignition of the electric fluid, (denominated a flash of lightning) should impregnate sound new beer with a considerable quantity of acid, must be a case of conjecture, of which at present no proof can probably be furnished: but the conjectural opinion is, that the atmosphere in contact, and in the immediate vicinity of the beer, is highly charged with the electric fluid, in connexion with that which has been subject to ignition; and that the effect of the explosion is the decomposition of the remote fluid, and that an abstraction of its hydrogen occurring, leaves the oxygen to be rapidly absorbed by the beer, between which and its carbon, there is a strong affinity and powerful attraction; and this opinion is supported by the customary practice of some, to place an iron weight or other article upon the beer cask in a thunder storm, in order to prevent the acetification of the beer within, which is probably prevented by the union of the oxygen with the iron instead of the beer. But whether such is the mode of impartation or not, the fact is indubitable, that the impartation of oxygen to a vinous fluid is necessary to the formation of acetous acid; and as the formation of such an acid in beer, is the result of the ignition of the electric fluid, it is fair to presume that the impartation of oxygen occurs in consequence.

EMPYREUMATIC, ***the flavor imparted to any viscid substance which is burnt in boiling.***

To this evil distillers are exceedingly liable in the use of the crane neck still or any other, which does not furnish the means of returning the aqueous vapour that rises with the alcoholic, in a condensed state to the body of the still; as without such a desirable provision, the loss by evaporation of the spirituous and aqueous portion of the wash, soon so far reduces its fluidity, as to cause an adhesion of the extract of the grain to the bottom of the still, and which burns, or in other words is subject to destructive distillation; and the products rising in the form of gas become blended and condensed with the spirituous vapour, to which it imparts an exceedingly ill flavor.

To obviate such an evil, those stills are provided with a revolving apparatus, moved by suitable machinery, for the purpose of keeping the wash in a continual state of agitation, in order that no adhesion to the bottom may occur.

In the improved stills, provision is made for the condensation of the aqueous vapour which rises with the alcoholic, and its return into the wash; and as the whole of the spirit contained in a distiller's wash may be withdrawn from it in the ratio of less than 20 per cent, there is not the liability of the residue being subject to burning for want of agitation.

EVAPORATION, *the dispersion of vapour.*

All fluids may be decomposed by evaporation, resulting from the impartation of heat, but the evaporating temperature of different fluids very much vary; and as an axiom, the lighter the fluid, the lower is its temperature of evaporation.

The density or specific gravity of a fluid, is proportionate to the quantity of latent caloric which appertains to it as an invariable component; and by this rule, spirit is lighter than water, and consequently its evaporating temperature is lower; and by the same rule, oil is heavier than water and its evaporating temperature is higher.

The thermometric evaporating temperature of fluids is in amount, in the ratio of their respective specific gravities as compared with the specific gravity of the atmosphere.

But as relates to the amount of latent heat added to the thermometric heat of each, the evaporating heat of all fluids is precisely the same; and thus those fluids whose constituent amount of latent heat is small, require a large amount of thermometric heat to render the specific gravity of such fluids or any part thereof, less than the specific gravity of the atmosphere; and those whose constituent amount of latent heat is large, require a small amount of thermometric heat to produce the same effect; and the necessary condition to be fulfilled to effect the evaporation of a fluid, is to impart to it as much thermometric heat, as which, added to the latent heat of the fluid will render such fluid of less specific gravity than the superincumbent atmosphere.

The impartation of heat, so as to cause the evaporation of a fluid may be direct on its upper surface, without any change in the temperature of that fluid, at much distance below the upper surface, as we perceive it naturally effected by the sun's rays on the surface of water, causing a vapour to rise from it; and in such process we observe, the operation of the two laws to which heat is subject; in the first place the operation of the secondary law, or the law of equal diffusion, and in the second place the primary law, or the law of recession; for as the impartation of heat from the sun to the atmosphere is direct, so the superincumbent atmosphere in contact with, or in the vicinity of the water, being of a higher temperature than the water, an impartation of heat from such air to the water occurs agreeable to the law of equal diffusion; but such secondary law being opposed by the more powerful, the primary or the law of recession, the penetration of the heat into the body of the water is to a depth proportionate to the force of impartation; and the power of such force being expended, and the activity of the heat imparted reduced to a state of latency by its combination with a definite number of the ponderable atoms of water, a vapour is formed on its upper surface; and which being of less specific gravity than the atmosphere in consequence of the addition of the imponderable atoms of heat it evolates from the surface of the water agreeable to the primary law or law of recession.

An artificial impartation of heat on the same principle, will effect a similar result; but as relates to the impartation by the combustion of fuel, the method would prove most disadvantageous and expensive, because of the mechanical inconvenience; and the superiority of the law of recession to that of equal diffusion to which heat is subject, would cause the waste of the principal portion of the heat which by such method might be attempted to be imparted. The usual mode of mechanical impartation of heat to fluids for the purpose of causing their evaporation, is therefore at the lower surface, as a matter of choice and advantage, and in addition thereto, at the sides as a measure of economy. Thus in fixing a boiler, the form of which is the frustrum of a cone, it is usual to cause the flue which conveys the heated air, smoke, &c. to the chimney, to wind spirally round the sides of the boiler, because the surface of the bottom is too small, and its substance too thick for the transition of the whole of the heat from the air to the fluid, which is furnished by the fuel in combustion; and in order to prevent the loss of a considerable portion of heat which cannot gain access to the fluid through the bottom of the boiler, an opportunity is thus offered to its transmission through the sides, previous to its final escape by the shaft of the chimney.

The study of evaporation on scientific principles, embraces for its object, the generation and appropriation of as much vapour as is possible, in the least time, at the lowest cost, and productive of the greatest effect; and to pursue such a study with success, it is quite necessary first to know and understand the elementary principles of the subject, as a preliminary step to their advantageous application.

All fluids are composed of material atoms, and compounded of atoms of different species: the composition of different fluids vary, as to classes of atoms, or to the several proportions of the same species, or to their relative arrangement. Each simple fluid is composed of an invariable proportion of the several species of ponderable atoms, which are united and blended by an established and unchangeable law. In addition to the species and proportions of atoms of which fluids and all other bodies are composed, and which atoms are subject to the law of gravity, every body contains an invariable quantity of atoms of heat commixed therewith, as necessary to the constitution and continuation of such bodies, which heat is termed latent. The latent heat of solid bodies resides in the interstices resulting from the cohesion of the spherical atoms of which such bodies are composed; but the latent heat of fluids is more than sufficient to fill such interstices, and consequently the surplus quantity of atoms of heat prevent the cohesion of the ponderable atoms of which the fluid body is composed, and which preventive to cohesion, constitutes the distinguishing characteristic between a solid and a fluid. Illustrative of this fact, that which is termed water may be viewed in a triple state, a solid, a fluid, and a vapour. The latent heat of ice is contained in the interstices presented by the union and cohesion of the spherical atoms of oxygen and hydrogen, and it is evident that those interstices are not quite filled with atoms of heat, as the impartation of a large quantity of heat is necessary to cause a separation of the atoms of oxygen and hydrogen from each other, and thereby convert the solid (ice) into a fluid, (water) as is evidenced by the experiment in taking an equal weight of ice and water, the latter at 172 degrees of heat, and putting them together, when it will be found, that the solid, (ice,) is converted into a fluid, (water,) and that the temperature of the mixture is but 32 degrees, the same as was the ice previous to its solution; the 140 degrees of heat serving to fill up the interstices, and to separate the atoms of oxygen and hydrogen from each other. The conversion therefore of a solid into a fluid, is effected by the overpowering of the attraction of cohesion, by which the ponderable atoms of which such body is composed are united, by the impartation of a sufficient quantity of the atoms of heat to forcibly separate them one from the other, with which capability the atoms of heat are endued, the law of equal diffusion to which heat is subject being superior to the law of attraction of cohesion, by which the ponderable atoms are held united.

The conversion of a fluid into a vapour, is effected by the impartation of heat to it, to an extent sufficient to render the ponderable atoms of which it is composed, together with the latent heat of which it is constituted, and the heat imparted, a body of less specific gravity than the superincumbent atmosphere, when in such case it ascends therein in the form of vapour. In the conversion of a fluid into a vapour, the ponderable atoms of which it is composed, are separated from each other, to a much greater distance than they were relatively situated in the fluid; yet are they not separated beyond the sphere of attraction of aggregation, and while remaining within that sphere, they, together with the imponderable atoms of heat, constitute an integral gaseous fluid.

In the decomposition of a vapour or gaseous fluid, the effect may be produced by the impartation of heat to it, to an amount sufficient to separate the ponderable atoms which enter into its composition, beyond the sphere of attraction of aggregation, when such atoms being no longer under the influeuce of such power, enter into new combinations, and the integral condition of such body is destroyed. By another method the decomposition of a gaseous body may be effected, and not only a gaseous but a liquid or a solid body; which is accomplished by the abstraction of the ponderable atoms successively from either of those bodies, by an attraction of the ponderable atoms of which they are composed by other bodies, in contiguity and vicinity; and which attraction is superior to the aggregate attraction by which those atoms were held together when constituting such bodies: and their decomposition may be yet further effected by an attraction of the atoms of other bodies by either of such bodies, by the resulting union of the extraneous atoms with their integral atoms, and the subsequent disengagement and evolation of both the extraneous and integral atoms from such bodies, by the combination of a sufficient quantity of latent heat rendered active therewith, as to create a gaseous compound specifically lighter than the surrounding atmosphere.

The wise and beneficent effect resulting from the operation of the two laws to which heat is subject, is admirably exemplified in the process of evaporating fluids; the heat imparted passing through the bottom of the containing vessel to the lower surface of the fluid, and rising to the upper surface in obedience to the primary law or law of recession from the centre of the earth, combines with the ponderable atoms of the fluid that form the surface strata, and expels them beyond the limits of the sphere of attraction, subsisting between them and their associate atoms, and uniting with them, form a gaseous compound, lighter than the air in which it floats; and thus the decomposition of the fluid is gradually effected, by the operation of the secondary law or law of equal diffusion, which is evidenced by the continued transition of heat from the burning fuel to the fluid in obedience to such law, the temperature of the incandescent fuel being much higher than the attainable temperature of the fluid.

To the brewer the process of evaporation is of much importance, when he requires the whole of the obtainable quantity of the extract of malt in a small quantity of wort; for as the obtainment requires a sufficient and definite quantity of the dissolving menstruum, so, should the resulting quantity of wort be more than is sufficient for his need, it is necessary that he should decrease that quantity by evaporation in the copper and cooling backs.

The distiller and vinegar maker are also deeply interested in the subject as relates to brewing, and the distiller and rectifier as relates to the separation of spirit from the compound fluids in which they may possess it.

All manufacturers who avail themselves of steam as a motive power for the propulsion of machinery, are still more strongly interested in the process of evaporation, as relates to the production of steam at the least cost, the most effective in power, and generated with the greatest rapidity.

The production of steam at the least cost, involves the following, as some of the considerations connected with its accomplishment: that species of fuel which will furnish the most heat in the ratio of its cost. That system of impartation of the heat evolved in the combustion of fuel, as is attended with the least loss either by radiation or escape by velocity. That system of impartation which will furnish as extensive a surface of the conveying medium of heat to the fluid as is possible, and as extensive a surface of the fluid as is practicable. That mode of impartation which is agreeable to the primary law or law of recession to which heat is subject, as far as mechanical capabilities, and manufacturing conveniences will admit; or in other words the impartation of heat through the bottom of the containing vessel to the greatest possible amount; and in addition, and in obedience to the secondary law or law of equal diffusion, the impartation of as much of the heat as cannot be imparted through the bottom of the containing vessel, through its sides or other surface during the transition of the heated air, gases and vapours, from the furnace to the chimney. The construction of the vessel in which the generation of steam is effected, of the most suitable metal for the prompt transmission of heat to its containing fluid, and of the least thickness, consistent with safety and ultimate economy. That form of vessel best adapted for the prompt, extensive, and economical transmission of heat to the containing fluid. The best method of fixing such vessel, the form and size of furnace, the situation and arrangement of the flues, the height of the chimney, the supply of air, the abstraction of its moisture and the increase of its temperature previous to its appropriation for the purpose of supporting the combustion of the fuel, the subsequent appropriation of that heat which is evolved in the combustion of the fuel, and which passes the vessel without being transmitted through it, and the appropriation of the waste steam to some useful purpose.

EVOLATION, *the act of flying out or away.*

The earth is surrounded by, or enveloped in a thin subtle fluid, which may for distinction be termed air as relates to such fluid in its simple and unmixed state, or atmosphere as relates to its mixed state with gases vapours, &c. This ærial fluid either in a simple or mixed state, is much lighter than any terrestial substance, and consequently neither solids or liquids will float or remain suspended therein, in their natural state. But as the decomposition of solids and liquids is necessary to the vivification, the sustenance, the comfort, and the pleasure of all animate and inanimate things; and as the products of decomposition would clog and mar the operations of nature, if strewed and scattered around as waste materials upon her finished works; providence has most wisely and beneficently granted the vast expanse of atmosphere, as the recipient of the excretory principles resulting from decomposition, wherein they float until again required for the recomposition of substances, or their accretion to existing bodies.

The action by which the transference of the excretory principles resulting from the decomposition of terrestrial substances to the atmosphere is effected, is termed evolation; and the means by which those atoms which constitute solid bodies of much greater specific gravity than the atmosphere, and which atoms in a conjunctive and detached state are ever subject to the law of gravity, are made to float and remain suspended in the atmosphere, are, the accompaniment of each detached ponderable atom by a sufficient number of the imponderable atoms of heat, as together constitute a gaseous compound of less specific gravity than the surrounding atmosphere.

To fully comprehend this subject, it is first necessary to know (that which has already been endeavoured to be taught) that all terrestrial substances are compounded of (what may be termed) ponderable atoms; a property derived from the law of gravity, or tendency to fall toward the centre of the earth to which they are subject; and of imponderable atoms, which property is derived from the law of recession, or tendency to recede from the centre of the earth. The atmosphere which surrounds the earth is also composed of ponderable and imponderable atoms; and the relative specific gravity of the terrestrial, or solid and liquid substance, and the atmosphere, is proportionate to the amount of the ponderable atoms, of which a given bulk of either is composed in conjunction with the imponderable atoms; and should it be requisite to render a solid or fluid body of less specific gravity than the atmosphere, and thereby enable it to float therein, it is sufficient to impart to either body as large a quantity of heat as will separate the ponderable atoms of which it is composed as far from each other, as will cause a smaller number of the ponderable atoms to occupy the same place as do the ponderable atoms of an equal bulk of the atmospheric air; and a solid or liquid body thus rarefied or dilated, will evolate from its situation and become the temporary resident of the atmosphere, until an abstraction of a portion or the whole of the heat imparted occurs, when the ponderable atoms of which the body is composed, and which have not been separated from each other beyond the sphere of aggregate attraction, are brought closer together by the exertion of that power; and as in such case the ponderable atoms occupy a less space than the ponderable atoms of an equal bulk of atmospheric air, so the specific gravity of such body becoming greater than the atmosphere, it falls again to the earth from which it had evolated: and the same results which occur to an entire body, happen also to any portion of such body; and as illustrative of this theorem, we may refer to the evolation of water from the surface of the earth, and its transition to the atmosphere in the form of vapour, and its subsequent condensation and descent to the surface of the earth in the form of rain, hail, snow, mist or dew; and upon an investigation of the subject, we shall find, that this twofold operation is effected, by an impartation of heat from the sun to the upper surface of the water in sufficient quantity to cause a separation of the constituent ponderable atoms of the surface of such water far enough apart, as to render a given quantity of such atoms in union with its constituent imponderable atoms of heat, and the heat imparted of less specific gravity than an equal bulk of the superincumbent atmosphere, and consequently it ascends and floats in such atmosphere to a height above the earth, as where the atmosphere and evolated vapour are of equal specific gravity; and the assemblage of large masses of aqueous vapour in combination with various gases, constitute the clouds, which retain their integral state until an abstraction of heat from the aqueous vapour takes place, and a transition of such heat to the colder atmosphere occurs, when the ponderable atoms return to their original station as in the state of water and form rain, or close contact as in the state of snow or hail, and impelled by the law of gravity, fall with a velocity to the surface of the earth, in proportion to the height to which they had attained, and the weight of the drops, flakes, or masses which they have assumed as the result of condensation.

Thus far we have discussed the subject of evolation, as but the result of an expansion of an integral body, or the integral portions of an integral body by the impartation of heat, of the consequent diminution of its specific gravity, and the decrease to an amount below that of the superincumbent atmosphere; the resulting evolation of such body or portion of such body into the upper regions of the atmosphere, the subsequent abstraction of heat from such expanded body or portion of a body, the consequent resumption of the original situation of its ponderable atoms or their closer contact, and the final descent of such body or portions of such body to the earth as impelled by the law of gravity to which their ponderable atoms are subject; and it now remains for us to endeavour to treat of the subject of evolation, as relates to the separation of the ponderable atoms in the decomposition of solid and liquid bodies, to an extent beyond the sphere of aggregate attraction, and of the consequent diminution, annihilation, or alteration of their integral state; and to avoid unnecessary repetition, we propose to entertain the subject under the next head, " Excretory."

EXCRETORY, *the evolation or separation of superfluous parts.*

The term excretory, is closely connected with and naturally follows the term evolation, because it is expressive of the general effect or purpose of evolation, which is to divest substances of the superfluous portion of constituent atoms which they possess, as relates to the intended change to be effected in their composition, or the appropriation to which they are designed.

The decomposition of bodies may be divided, or classified under the heads of mechanical and chemical, and subdivided under the heads of partial and total decomposition.

A partial mechanical decomposition of a substance, is generally intended to separate some portion of it, which is deemed a superfluous appendage, for the purpose to which such substance is to be appropriated; or a division of it, to facilitate some chemical manipulation which it is intended it should experience.

A partial chemical decomposition of a substance, is a process performed for the separation of a portion of the constituent atoms which are deemed superfluous, or inimical to the purpose for which the substance is required; and therefore the superfluous atoms may be termed excretory; and they may be separated by the agency of heat alone, if the diminution of the bulk of the substance is only required, by a separation of any of the classes of atoms indiscriminately, of which the substance is composed; and which may be effected by the impartation of heat to the substance, to a sufficient amount, as will place a portion of the ponderable atoms of which the substance is composed, beyond the sphere of attraction of aggregation subsisting between the detached and resident atoms; but if the purport is to separate a portion of any particular class of atoms from the main body, with a view to alter the properties of the substance, or to deprive it of any peculiar properties which the presence of those atoms intended to be separated may confer upon it, it then becomes necessary to call in the agency of affinity and attraction, in addition to or without the agency of heat, to cause the separation of any portion or the whole of the class of atoms which it is requisite should be separated from it.

If an indiscriminate portion of the several classes of ponderable atoms of which a substance is composed is separated from it, for the ultimate purpose of a diminution of its bulk merely, by the impartation of heat; as a matter of course, the heat imparted must be subsequently abstracted, when it has fulfilled the purpose for which the impartation was made; and also when called in as an auxiliary to the power of affinity and attraction, for the purpose of causing the separation of any particular class of atoms.

If it is intended to cause the abstraction of the whole or any portion of a particular class of atoms from a substance, and impart atoms of another class to such substance, with a view to change the properties, &c. of the substance, the power of affinity and attraction must be exercised to effect its accomplishment, and most probably the agency of heat as an auxiliary.

In the process of malting, the first mechanical operation is to immerse the grain in water for a given period; and the first chemical operation, is a solution of the oleaginous or resinous substance, with which the husk or skin of the grain is coated by the water, and which being dissolved the skin is rendered permeable, and the water penetrates into the body of the grain, and the oxygen of the water unites with the carbon of the grain and forms carbonic acid. The second mechanical operation is to withdraw the steep water which the grain has not imbibed, and to remove the grain from the cistern to the couch; and the second chemical operation is the impartation of oxygen from the atmosphere to the grain, a portion of which combines with its carbon, and a portion with its hydrogen; carbonic acid being the result of the first named combination, and saccharum of the second. The third chemical operation is the conversion of the carbonic acid into gas, by the addition to it of heat which has been liberated from its state of latency by the partial decomposition of the grain, air, and water, and being thereby rendered active it unites with the carbonic acid, and renders it of less specific gravity than the superincumbent atmosphere, and consequently it evolates from the grain, and thus a portion of the carbon of the grain, the presence of which is superfluous as relates to the future purpose to which the grain is intended to be appropriated as malt, is separated therefrom as an excretory product of the process of germination. The third and subsequent mechanical operations from the couch to the kiln, is to spread the grain on the floor at a suitable depth, and to rake and turn it occasionally, to facilitate the impartation to it of oxygen from the atmosphere, and the abstraction of carbonic acid gas from it. And the final mechanical process, is to throw the grain on the kiln to evaporate from it the residue of the water which it had imbibed, and to facilitate the impartation of more oxygen to it from the atmosphere by the aid of heat, for the formation of more carbonic acid gas and saccharum, and the supply of the requisite color and flavor: and as the result of these various mechanical and chemical operations, it will be found that the total quantity of malt and malt dust, is of considerably less weight than the original weight of the barley previous to its being steeped; and that consequently by the process of malting, the balance between the amount of ponderable atoms imparted and which remain resident, and the amount of the ponderable atoms abstracted, is much in favor of the latter.

In the process of brewing, the insoluble portion of the malt denominated grains, may be termed the excretory product; and in the process of boiling, the gluten which is coagulated.

In the process of fermentation, the excretory products are carbonic acid gas, and coagulated gluten; the carbonic acid gas being created by the impartation of oxygen to the wort from the atmosphere, by its union with the carbon of the wort, and thereby forming carbonic acid, by the removal of the carbon and oxygen from their previous situations to form such union, and the consequent liberation of latent heat and its conversion into active heat, which uniting with the carbonic acid converts it into gas, and which being so converted and rendered specifically lighter than the superincumbent atmosphere by the union with it of a sufficiency of heat, it evolates from the upper surface of the wort as an excretory product. The coagulation of a considerable portion of the gluten contained in the wort is effected by the affinity and attraction subsisting between the coagulated gluten imparted to the wort in the state denominated yeast, and the uncoagulated gluten diffused in a state of chemical admixture with the other component substances of the wort, aided and facilitated by the carbonic acid gas introduced with the yeast and enclosed in its vesicles, and the subsequent decomposition of the wort and the formation of carbonic acid gas, from the union which occurs between its carbon and latent heat rendered active, with the oxygen of the atmosphere which is imparted to it, and the two excretory products are separated from the wort; the carbonic acid gas, as the result of its less specific gravity than the atmosphere, and the coagulated gluten, as the result of the inflation of its vesicles by carbonic acid gas, rendering it of less specific gravity than the wort, and aided also by the continued ascent and buoyant properties of the carbonic acid gas, not enclosed in such vesicles, from the lower surface to the upper. As the impartation of oxygen from the atmosphere to grain in the process of germination is for the purpose of abstracting a portion of its carbon and for the formation of saccharum; so the impartation of oxygen to wort from the atmosphere in the process of fermentation, is for the purpose of abstracting a portion of its carbon and the formation of spirit; and as a diminution in the weight of the grain occurs in the process of germination, so a diminution of the weight of wort occurs in the process of fermentation; the balance between the amount of impartation and abstraction, as relates to the final result, being in both cases in favor of the latter.

EXPEDITIOUS, *quick*, *ready*, *active*, *alert*, *nimble*.

In teaching youth the instructive maxim is, "First learn to do well, and next well and quick."

Another maxim, "time is money," will serve to illustrate the motive for recommending expedition in accomplishment, next to a good performance.

The necessity and desire to perform a process in any branch of manufacture well, with a view to ensure the obtainment of the product of good quality, as a preliminary step to the realization of profit, has induced the slow and tedious performance of many operations which the manufacturer has not well understood; because having to act without a comprehensive knowledge of the chemical and mechanical departments of the manufacture, he prefers to err (as he terms it) on the right side, which he considers as the slow and cautious process, rather than on what he conceives to be the wrong side, the expeditious; and because some for want of judgment, or through cupidity, have unsuccessfully departed from his system, he clings the more closely, and with invincible tenacity to all ancient usages and customs; and overlooking those who have advantageously deviated from and improved upon his system, he ever points to the disasters of the unsuccessful, instead of comparing his own results with those of each, and profiting by the careful examination, deriving benefit by an avoidance of the errors and follies of the one, and by the adoption of the improvements of the other.

Expeditious.

There are but few manufacturing processes that are not divisible into the departments of chemical and mechanical; and it is not only desirable that every manufacturer should be conscious of such a divisibility of his several processes, but that he should also possess an accurate knowledge of the elementary principles of either department in order that he may ascertain if improvement in either is needed; and if needed, how it may be effected; and if effected that the improvement in the mechanical department, does not disadvantageously affect any part of the chemical process.

It too often occurs that the manufacturer who neither understands the chemical or mechanical departments of his business, calls in the aid of a mechanist to effect some mechanical improvement, who accomplishes the purpose, with the accompaniment of some chemical injury, or the destruction of some chemical benefit: and thus in the absence of an elementary knowledge of the process of germination, the steep water is often introduced into the malthouse cistern at 32 degrees of heat from some reservoir, instead of at 50 or more degrees of heat from the well, because it is more mechanically convenient. Solar light is also ushered into the malthouse, although nature performs the process of germination in situations inaccessible to it, because the mechanical operations of turning and raking, can be more conveniently and economically performed by its aid than without it; and its admission too, must often be accompanied by an amount and temperature of atmospheric air, highly injurious to the process of malting, because forsooth, unglazed shutters are cheaper than glazed sashes.

These and many more mechanical arrangements, inconsistent with the advantageous and expeditious performance of the malting process, might be enumerated, to illustrate the losses sustained and the evils experienced, by the non-possession of an elementary knowledge of the chemical department of the process of malting.

Nor will the brewery fail to afford ample opportunities to illustrate the injurious collision between mechanical arrangements for the performance of chemical operations, and the endeavours of the brewer to perform them on correct principles. He may desire pure water as a menstruum for solution, but mechanical convenience, parsimonious considerations, or ill judged arrangements may frustrate his wishes. He may wish and know how to administer a proper quantum of heat to his menstruum for solution, but owing to an unsuitable contrivance for the conveyance of it to the mash tun, he may lose a variable and indefinite portion of such heat before it reaches its destination, and which the variable and indefinite amount of its loss, prevents him from making suitable provision for. He may get it to his mash tun at a proper temperature, and be desirous that as small a loss of heat as is possible should occur after it has reached there, well knowing that if it is necessary to choose and obtain a proper temperature of the menstruum to effect a solution of the several substances of which the malt is composed, in relative proportions and to a correct extent, and well knowing also, that as solution is not instantly or rapidly effected, that therefore the heat of the menstruum and malt, (technically called the goods) should be preserved as much as possible; but it may be that the mashing apparatus is of that unsuitable mechanical construction or capabilities, that it neither performs the process of mashing well, nor yet with expedition, and much of the heat of solution is very disadvantageously lost. The next mechanical evil in his way, may be the unnecessary utensil called the under back, with its appendage the wort pump, to say nothing of the several defects of either, causing the loss of wort by adhesion to its surface, of heat by exposure to the atmosphere, and the absorption of oxygen from the same source, beside the loss of much time and labour; all which might be avoided at a less outlay of capital, and the realization of a produce of better quality, obtained with more ease, and less current expenditure, with the saving of a considerable portion of time. If we remove from the under back to the copper, and find but one on the premises, which is always sufficient for a single brewing in one day, we often find an ample scope for a reprobation of the principles of its construction, the inconsistent and unscientific mode of its setting, its size, its form, or some other mechanical inconsistency or imperfection; and note the waste of time in getting the wort to boil, the immense waste of fuel, and wear and tear resulting during the process of heating and boiling; the waste of wort by adhesion, the loss of steam by inappropriation, without stopping to point out the chemical injuries sustained, and many more mechanical that might be enumerated. Well; we will next travel to the hop back, and surely there we shall find all right! But no, for mechanical economy and absurdity has there been at work too, and instead of finding a utensil constructed of proper material, size, and mechanical convenience, we perhaps find a small lattice frame, covered with (probably) a ragged hair cloth, which absorbs and wastes more wort in a year than a good and proper hop back would cost. Let us next pass on with all imaginable patience to the cooling backs, and visit them on a hot summer's day, perhaps covered with wort to the depth of 3 or 4 inches, reflecting from all parts the brilliant rays of a meridian sun, which find their access through the lattice shutters as a substitute for the cool breezes which they were intended to admit, and inverting the order of intention, they warm instead of cool; let us next cast up our eyes to the roof to ascertain the material of its covering; and perhaps we perceive the neat blue slate, or the glaring red tile, and we cautiously venture to touch them with our fingers to ascertain their temperature, but pay with a smart for our presumption: we next examine the indications of a suspended thermometer to ascertain the atmospheric heat, and find it range from 80 degrees to 90, and while ruminating on the term cooling backs in such a situation, on the vinegar manufacturer's wort in the stove room at the same or a lower temperature, deriving oxygen from the atmosphere for the purpose of acetification, which such a temperature promotes, we are perhaps astounded with a stunning clap of thunder and thereby reminded of the presence of electric fluid in the atmosphere; and ceasing our investigations, and at the same time consulting our safety, we descend into the more genial and refreshing regions of the cellar, satisfied (as no doubt our readers will by thus much be) "that there is nothing perfect under the sun." Had we looked into the tun room and seen fermenting tuns almost hermetically sealed, to prevent the loss of spirit which never evaporates in fermentation; and the escape of carbonic acid gas, for which nature has so skilfully and admirably contrived every facility for its evolation from the wort during the process of fermentation; and had we seen the refrigerators and accelerators in the tuns, furnishing remedial antidotes for evils that should never exist; had we looked into the cleansing rooms and seen the large fires to prevent the beer from freezing, or the cessation of fermentation; or the watery ablutions, the ventilations, and the nocturnal visitings of the summer breezes carrying off the accumulated heat, emanating from fervid fermentation conducted within, and by impartation from without; and many other rooms beside, we might have told a tale of incongruities, as long as a summer's brewing in such ill contrived and inconvenient premises.

It has often been our hapless lot to be 28 hours in getting through a brewing, from the time of first mashing until the whole of the worts were in the fermenting tuns pitched at above 70 degrees of heat, and the wort perceptibly acid before it entered the tun in such premises; and it has been our happier circumstance, often to have performed the same operation in premises of our own contriving and fitting up, in the space of eight hours, pitching the wort at 60 degrees in the middle of a sultry summer's day, in a thoroughly sound and excellent condition; the latter premises and its fittings, costing very much less than the former, and yet capable of producing double the annual quantity of beer.

EXPERIENCE, *knowledge obtained by practice.*

Knowledge may properly be divided into two sections and one portion may be termed theoretical, and the other practical.

The term experience, applies to knowledge resulting from theory and practice combined, or from practice alone.

Experience derived from practice alone, is doubtlessly very valuable, and is more profitable and serviceable than knowledge obtained from theory alone, but theoretical knowledge first obtained, and such knowledge well tested, proved, and confirmed, by long continued practical observations and results, demonstrative of the correctness of a theory, is far more valuable than knowledge solely derived from either division separately.

Many possess a most extensive and well selected stock of theoretical knowledge, derived from reading and conversing only; and in conversation with them on many subjects, they appear to possess a large fund of information on each; but like a second-hand garment, however valuable it may be, and however comely may be the appearance of the possessor therein, yet the experienced practitioner will soon discover that he is not the original owner, and that his knowledge is but second-hand.

Again; many possess much valuable practical knowledge alone, none of which is the result of reading, but that of practical information personally communicated by some instructor, or is the fruits of the imitation of others, resulting from the close and attentive observation of their practical operations; and to information thus obtained, they may add a small portion of original practical knowledge, proceeding from some accidental discovery made during the performance of some practical operation, or from the results of experiments purposely made, with a view to the obtainment of more knowledge.

That imitative knowledge is valuable, is unquestionable; but that original knowledge, or such as is obtained from reflection and deduction, from mental analysis or synthesis, the construction of an hypothesis, and the subsequent practical operations and experimental proofs, reflects a far superior lustre on the talents of the discoverer, than does such as is obtained by the mere imitator, is equally indubitable.

The primary purport of seeking knowledge, is, as a general rule, the obtainment of wealth.

In every branch of trade, commerce, and manufacture, a competent knowledge of the business which it is intended to follow, is without hesitation admitted to be an indispensable requisite to ensure success.

In the division of knowledge, theory precedes practice, as reflection stands before performance; but such is the perversity of the human mind, the general disposition to indolence, and the inveterate prejudices of habit and education, that in endeavouring to impart instruction, or to obtain knowledge, practice is allowed to precede theory, or the latter remains unsought, contemned and rejected.

Apply these observations to the manufacturing business of a maltster, brewer, distiller or vinegar maker, and their force will be duly appreciated by the diligent observer.

The scholastic education of a youth, intended to conduct either of those branches of business, has no reference (as a general rule) to the acquirement of that peculiar theoretical knowledge, connected with the practical details of the process, which it is intended he should superintend, and he leaves the school in which he has received the rudiments of a general education, and is transferred to the manufactory to learn a practical system, upon the same principle as a parrot learns to speak; and the value of his acquirement depends upon the value of the system which may have been fortuitously adopted by his instructor: and it is no uncommon circumstance to hear those who have been thus instructed, declare at the end of thirty or forty years practical experience, their great ignorance of their business and express a strong desire at an advanced age, to obtain that rudimental knowledge, which should have been acquired at a time of leisure and mental vigour.

The army, the navy, and the church have their respective colleges for the special instruction of youth, in those branches of education immediately connected with their future possessions; and why not the manufacturing and mercantile part of the community? In such an institution those who are intended to become manufacturers, should be instructed in natural philosophy, chemistry, mechanics, hydrostatics, hydraulics, &c. and as such seminaries are yet needed, it becomes a question of serious consideration, whether those who are intended to fulfil the most important duties of extensive manufactories, should not be well instructed in all the theoretical and practical details of the business they are about to manage, previous to their filling so great and responsible a situation.

EXPERIMENT, *to try, to prove, to search out by trial.*

A strong prejudice exists in the minds of many, against experimentalists, whom they with more spleen than good nature, denominate schemers, speculators, &c. forgetting at the same time, or never thinking, that they are indebted to the discoveries of such persons for an immense number of necessaries, comforts, and luxuries, with which they are daily surrounded. Such prejudice has been inculcated from a review of the disastrous consequences that too often result from an indulgence in the praiseworthy pursuit of knowledge, to an extent beyond the person's pecuniary means, a reasonable leisure, and on a scale of greater magnitude than is needful or consistent.

Excess in every mental and bodily avocation, however rational and proper the employment; in every sensual gratification, however plain and wholesome the food or beverage; in every recreation, however harmless, exhilirating or salutary; becomes pernicious in proportion to the extent of the indulgence, or the capabilities of the mental and bodily powers to sustain it, or the pecuniary resources to supply it.

Previous to attempting an experiment, an enquiry should be made, on how small a scale can it be effected? How small and inexpensive the apparatus needed? The probable cost of the attempt, compared with the value of the discovery that may possibly be made? The personal or relative value that may be derived or the utility that may result? If the time and money can be spared to make it? If these and other questions were mentally propounded, previous to the embarkation of the mental and bodily energies, in undertakings beyond the pecuniary resources of the ardent enquirer after knowledge, or the eager inventor, striving to discover a short and easy road to fame and fortune, many a destructive precipice might be avoided, and many a substance saved while grasping after shadows. But genius is seldom allied to prudence, and prefers a residence in an ardent, sanguine, and ambitious mind, rather than to take up her abode with the dull, plodding money getting disposition, and a little reflection should teach the members of either class, that contentment with their own condition, and respect for the temperament of others, is much more consistent than ridicule, contempt or reproach.

EXPLOSION, *a violent noise, concussion or distribution.*

Numerous manufactories are subject or liable to the disastrous effects of explosion, in which highly inflammable substances are manufactured, such as gunpowder, detonating powder, gas, &c. and also in such as generate steam as a motive power.

As those to whom this work is more particularly addressed, are extensive employers of steam engines, all information which is calculated to throw light upon the cause of the explosion of steam boilers must be useful, in proportion to its probable approximation to the facts of the case.

Much diversity of opinion has prevailed and still prevails, as to the general cause of the bursting of boilers; and until the question is set at rest, by some discovery of that indubitable character, as will command a universal consent as to the real cause in all cases, every opinion furnished is respected in proportion to the probability of its correctness, or the reputation of the individual who furnishes it.

It is usual with many steam boiler manufacturers, to test the strength of every new boiler before it is sent from their premises, with a view to ascertain the amount of internal pressure it will bear, without the liability of bursting, and it is the practice to furnish such as will bear double the pressure that it is expected they ever will be subject to, such an allowance being deemed sufficient for the effect of wear, and the occasional unnecessary pressure caused through accident or carelessness.

But notwithstanding such precautious and the suitable provision of safety valves, explosions frequently occur from some cause, which from the circumstances resulting from such a catastrophe, cannot be discovered by enquiry or investigation, and conjecture furnishes the cause instead of conviction. The various conjectures of scientific and practical men can only be offered therefore, instead of convincing proofs; and as they furnish suggestions for several necessary precautions as preventives to the various liabilities of bursting, they cannot be too generally known.

The thoughtless, careless, or designedly overloading the safety valve may be the cause: a prevention of the liability may consist in locking them up, the master keeping the key. Another cause; the adhesion of the safety valve to its seat from some unavoidable and unexpected cause: the precaution, a frequent raising of the safety valve, which may be easily effected although locked up. Another cause; the generation of steam more rapidly by too intense a fire, than can pass with equal rapidity through the eduction pipe and safety valves, and the consequent pressure of steam exceeding the boiler's capability to sustain it; and the same effect may be produced while generating steam at a moderate rate and with a suitable fire, by the sudden closing of the eduction pipe, induced by a variety of causes, or the non-condensation of the steam in the cylinder of the engine: precautions; a general attention to every department of the apparatus, to its cleanliness, its state of repair, its gradual wear, the frequent raising of the safety valve, the sufficient lubrication of the parts required, and the prompt checking of the fire in a case of emergency.

A cause not so well understood or generally known, originates from the supply of water to the boiler, not being proportionate to its consumption, by its conversion into steam; and this insufficient supply may be the result of carelessness, or some accidental and unavoidable circumstance. If the water in the boiler is allowed to get below the prescribed water line, there is a liability of the boiler becoming red hot above the surface of the water, and it is supposed by some that as the tenacity of metal at a red heat is not so great as at a black heat, that the strength of the boiler is diminished below the amount of the pressure of the steam when at a red heat, and that its bursting is a necessary consequence. But others are of opinion, that the disruption of the boiler is to be attributed to the formation of hydrogen gas, and its ignition in consequence of the heated state of the metal; and they account for the formation of the hydrogen gas in this way: that as water is a compound of oxygen and hydrogen, and that as there is a great affinity between heated metal (more particularly iron) and oxygen, that as soon as the metal attains to a red heat, an abstraction of oxygen from the steam and its union with the metal occurs, leaving the boiler charged with a volume of hydrogen gas instead of steam, and which is ignited by the metal, and by its explosive power rends the boiler with a devastating force, commensurate with the extent and condensation of the volume. Others there are, who suppose that boilers frequently become red hot even below the surface of the water, whether charged to the water line or not, in consequence of the formation of an internal coat or crust, by the deposition and accretion of the calcareous matter that is diffused throughout the water with which the boiler is continually charged, and which tenaciously adheres to the surface of the metal; and this coat or crust intervening between the metal and the water, and the transition of heat from the metal to the water not being so rapid in consequence, as it occurs from the fuel to the metal, it gradually attains to a red heat in that part where it is most exposed to the action of the fire, and continually extending, it finally reaches above the water line, and thereby the formation and ignition of hydrogen gas occurs as before stated; or the tenacity of the metal is so far diminished, as to render the pressure of the steam superior to the strength of the boiler, and its disruption consequently ensues.

There are yet others, who are of opinion that the transition of heat from the fuel through the boiler let it be ever so clean, may be so rapid and to such an amount, as to exceed the receptive capabilities of the water, and that such surplus quantity of heat must therefore be collected and retained in the metal and to an amount sufficient to raise it to a red heat; and as the receptive capabilities of water for heat are in the ratio of the amount of its impartation, so therefore if the impartation of heat from the fuel to the boiler is more rapid and to a greater amount than its escape from the boiler, there must be an accumulation of heat either within the boiler, or in the metal of which it is composed, furnishing an explosive power beyond the capability of any metal to resist it.

But whichever may be the real cause, or on the supposition that occasionally either cause may effect so diastrous an occurrence as the bursting of a boiler, the obvious preventive precautions are, to keep the supply of water to the boiler well up to the water line; to continue the supply in the ratio of its consumption by the generation of steam, to prevent the encrustation of the metal to a dangerous extent; not to allow the accumulation of steam in the boiler in a compressed state to exceed in elastic force the resisting capabilities of the boiler, or to allow the impartation of heat from the fuel to the water to exceed in rapidity and amount the generation of steam in the boiler, or its exit by the eduction pipe.

EXTRACT, *to draw out of, to separate from, &c.*

The preparation of grain by the process of malting, not only changes the properties of the internal substances of which it is composed, but renders it better adapted for the process of extraction.

The breaking of the husk and the comminution of its contents, facilitates the access of the extracting menstruum to all the soluble parts, and the brewer's skill and judgment is needed as a matter of the first import, to regulate the heat of such menstruum, as not only to render it competent to dissolve as large a portion of the soluble substances of the malt as is possible, but also to prevent it from becoming the cause of not obtaining any, or a sufficient portion of extract, (an effect technically termed wholly or partially setting the goods).

Totally setting the goods is an effect too evident and too disastrous to be mistaken by a brewer of the least experience; but a partial setting of the goods from the choice of improper mashing heats, and the insufficient obtainment of extract as a necessary consequence, frequently occurs with the most experienced brewers, and to a much greater extent with those whose judgments and practice are guided by erroneous views and the prejudices of an arbitrary and undeviating system, or who do not possess that information which is necessary to the conception and adoption of a correct one.

Partially setting the goods, not only causes the obtainment of an insufficient quantity of extract, but that which is of inferior quality also, as is evident to the skilful discerner and experienced observer, in the subsequent fermentation of the wort obtained; and thus improper mashing heats inflict a double punishment—the loss of quantity and quality.

That there is a perfect first mashing heat for every quantity and quality of malt that is brewed, so as to obtain therefrom as much extract, and of as good quality as it is capable of yielding, is doubtlessly a fact; and that no one does or can possess a knowledge of that variable perfect heat is equally true: but that an approximation to a perfect heat may be known, and is known to few is also certain; and might be known to more, by an acceptance of the author's offer to communicate the information by which it may be ascertained.

If any one has ascertained the heat of the grist of every brewing for one year or more, he may have discovered (as the author has done) a variation in the temperature to an extreme extent of about 50 degrees during the year, and an extensive variation of heats between; and if we are to believe the assertion of several authors on the subject of brewing, that the heat of the first wort as it runs from the mash tun into the under back, and when about half the quantity is down, should range from 140 to 150 degrees of heat; how can it be possible, that the adoption of one invariable mashing heat all the year round for malt, the temperature of which is subject to such extensive variations, can furnish to the goods or to the resulting wort, an average temperature of from 140 to 150 degrees; and of those who adopt such an invariable heat, or do not vary more than 10 degrees in the first mashing heat in the year's practice, or attempt to judge by the color, the flavor, the brittleness or toughness, the dry or damp condition of the whole or ground malt, what should be the proper first mashing heat, I would ask the following questions. If there is so great, or a less variation as 50 degrees in the temperature of the grist in one year (and every brewer should prove it to be a fact or not) can one invariable mashing heat for the whole of the year, be an invariably perfect heat; or can an approximation to it be obtained by a variation of the first mashing heat within the range of 10 degrees; or can the color, flavor, the free and dry, the tough and damp condition of the malt, or even the temperature of the whole malt be any rule to determine the heat of the grist at the time of mashing, and consequently what should be the proper temperature of the mashing menstruum? And are there no other considerations beside the temperature of the grist to be taken into the account of calculation, as to the proper mashing temperature?

Irrespective of proper temperatures of the mashing menstruum, its situation at the time of taking it; the mode, medium and circumstances of its conveyance to the mash tun; its distance from it; the time and mode of mashing; the exposure of the goods during the process; the time of the continuance of the wort thereon; and other considerations affecting the quantity and quality of the extract, are subjects of the highest importance, as relates to profit to be derived from the quantity and quality of the products, and the expenditure on their production; and the formation of a sound and advantageous system, requires all the aid of a well digested theory, combined with the experience resulting from close and attentive observation, and an extensive and long continued practice.

The constituent substances of malt are gum, sugar, starch, and gluten; and to convert good barley into good malt, it is requisite that the process of malting should be so conducted, as that these substances should form the component materials of the grain in due proportion to each other, subsequent to the completion of the process: and having good malt to brew, it is necessary that the process of extraction should be so conducted as to dissolve a due proportion of such substances: and having obtained a good extract, it is necessary that the wort should be boiled a due time and with sufficient speed, as to cause the coagulation of a proper quantity of the gluten which is extracted from the malt: and the process of boiling being properly performed, it is necessary that a proper proces of fermentation should be pursued, in order to complete those organic changes that must necessarily precede the production of good beer.

FECULENCE, *muddiness, foulness, sediment, lees.*

The feculent condition of fluids, may be caused by the simple or chemical admixture of various substances with a pure and transparent fluid, or by the suspension and diffusion of the excretory products of fermentation or decomposition.

Under the head of feculent by simple admixture, may be included all those fluids which are compounded of a pure and transparent fluid, and some substance mixed therewith which is held suspended and diffused therein, and which substance may be by depuration or filtration separated from such fluid; such as water mixed with earth, &c.

Under the head of feculent by chemical admixture, may be included all those fluids which are compounded of a pure and transparent fluid, and some substance dissolved thereby, and so intimately blended therewith as that it cannot be separated therefrom either by depuration or filtration; such as water mixed with the extract of malt and in that state called wort, &c.

And under the head of feculent by the excretory products of fermentation or decomposition, may be included all those chemically compounded fluids, which are subjected to fermentation or other mode of decomposition; and which during such process furnish excretory products which remain suspended therein in a state of simple or mechanical admixture; such as fermented wort in a feculent state, which may be brought to a state of transparency by depuration or filtration; or by attraction and precipitation as occurs in the process of fining by the aid of isinglass.

The excretory products of the fermentation of wort, are carbonic acid gas, coagulated and uncoagulated gluten.

Coagulated gluten or yeast, is an excretory product of fermentation, mixed with the wort in a state of simple mixture and may be separated from it by ejection, depuration or filtration; and uncoagulated gluten is an excretory product of fermentation mixed with the wort in a state of chemical admixture, and whose developement and condition is the result of a decomposition commenced and not finished, in consequence of the cessation or expenditure of the stimulating power to fermentation; and which may be separated from the wort by the attractive power of dissolved isinglass.

FERMENTATION, *the partial decomposition of a substance possessing certain properties, and the re-formation of another possessing different properties.*

Fermentation admits of a quadruple division, the vinous, acetous, putrefactive and panary.

A great variety of vegetable extracts blended with water in a state of chemical admixture, are liable to, and susceptible of either the vinous, acetous, and putrefactive fermentation; or conjunctively or consecutively may be subject to the whole.

The extract of malt being blended with water constitutes wort, and may be selected for the purpose of illustration.

The presence of sugar appears to be necessary to a vinous and acetous fermentation, or those elements of which sugar is compounded; but not so to the putrefactive; yet the presence of sugar or its component elements are not a preventive to putrefactive fermentation.

Wort needs the addition of yeast or some other adventitious substance to cause a vinous fermentation; and an impartation of oxygen from the atmosphere, (as relates to common practice) to ensure its commencement and continuance.

An impartation of oxygen alone from the atmosphere to wort to a sufficient extent will cause an acetous fermentation, without the precedence of a vinous fermentation; but an acetous fermentation is conducted with more expedition and advantage subsequent to the completion of the vinous process.

The putrefactive fermentation may be induced by the insertion of a putrefactive ferment, such as putrid yeast, or such as is derived from tainted vessels by extraction.

The three species of fermentation, or either two, may be conjunctively conducted by the insertion of good yeast, the impartation or transition of too much oxygen from the atmosphere to the wort, previous or subsequent to the insertion of the yeast, and by being put into tainted vessels, &c.

The three species of fermentation naturally follow each other consecutively, and necessarily and inevitably succeed each other, with a greater or lesser rapidity, as circumstances may induce, unless precautionary measures are adopted to arrest their progress, and prevent their transition from one stage to the other.

Vinous fermentation may be divided into two sections, as it is commonly effected by the brewer; the first, called the sensible or foul fermentation, which is conducted to a varied extent, dependant upon the circumstances under which the wort is produced, the heat at which it is pitched, the temperature and condition of the atmosphere, and the quantity and quality of the yeast. The second section is termed the insensible or transparent fermentation, and proceeds with a rapidity proportionate to the contingent circumstances connected with its mode of storing, &c.

If wort has passed through its first and second stages of vinous fermentation, without the conjunction of the acetous or putrefactive, the moment it has reached the utmost limits of the vinous process, the acetous commences.

The density of beer by Long's, Swan's, or Dring and Fage's saccharometer, that has attained to the utmost extent of vinous fermentation, varies from 1½ to 3lbs. per barrel; and at such point, it has generated the whole of the spirit which it is able to produce, and from such a density, it will gradually increase in amount, as the acetous fermentation proceeds, and the spirit generated, gradually diminishes in quantity, until the whole is converted into acetic acid. The acetous fermentation has also its natural limits, and when attained, the putrefactive fermentation commences, the whole of the acid gradually flies off, and the density once more decreases, leaving a putrid compound of vegetable extract and water. If wort is subject to an acetous fermentation in conjunction with the vinous, either in the first or second stage of the latter, the quantity of spirit generated by the conjunctive fermentation is less than is produced by the vinous fermentation alone, and the diminution in amount, is in the ratio of the extent of the acetous fermentation.

The rationale of the vinous fermentation of wort is its partial decomposition and recomposition, or the change of its properties and characteristics; and to effect this purpose, the abstraction of carbon and gluten and the impartation of oxygen and yeast is necessary.

Wort possesses much carbon as a constituent principle or class of atoms, and brewer's wort possesses a large additional quantity superadded in the extract obtained from hops, and the design of the presence of so much of it in the wort, naturally, and the impartation of so much by the medium of hops, appears to be to furnish time and means for the requisite combination of oxygen and hydrogen to form spirit, which is the primary purport of vinous fermentation.

Yeast in a suitable state to cause the commencement of, and promote the continuation of fermentation, must possess large quantities of carbonic acid gas enclosed in its glutinous vesicles; and which being well mixed with wort and those vesicles broken, the carbonic acid gas is set at liberty, and being of less specific gravity than the wort with which it is mixed, it causes an intestine motion throughout the whole body of wort in its ascension to the upper surface; which motion is necessary to facilitate the decomposition and recomposition of the wort, and the coagulation and ejection of the excretory gluten. The liberation of this carbonic acid gas from the vesicles of the yeast, is facilitated by mechanical trituration and by expansion resulting from the impartation of heat to it from the wort of a higher temperature than itself, with which it may be mixed; and to facilitate such purpose, yeast of the last production in fermentation, is found to be stronger or more powerful in fermentation than such as is ejected at an early period, or when the wort in fermentation is at its highest temperature.

Nature in the process of reproduction adopts similitude as her rule, and hence we find the production of her labours, composed of the same species of elementary principles, the same proportions, and subject to the same arrangement, as the original, from which the nucleus or any greater portion of the similitude was derived: hence in fermentation we find that the impartation of original products to the fermentable fluid, are necessary to the reproduction of the same; and as in all cases of fermentation or germination the similitude produced is much greater in amount than the original imparted, it is evident that the original which is imparted furnishes but a large amount of nucleus principles, to each of which an accretion occurs from the fluid and the atmosphere of the several classes of atoms which are necessary for the production of the similitudes. Thus as we find that in the process of the vinous fermentation of wort, that the substances produced are carbonic acid gas, coagulated gluten, and spirit; so shall we find on the analysis of yeast, that it is composed of carbonic acid gas, coagulated gluten and spirit; and therefore by the impartation of the single substance denominated yeast, we impart the treble substances of carbonic acid gas, coagulated gluten and spirit, and experience an abundant increase in the reproduction of each.

The single substance denominated yeast, or the triple compound of carbonic acid gas, coagulated gluten and spirit, being introduced into the wort, it is necessary that the thermometric temperature of such wort should be sufficiently high, as that a transition of its active heat to the yeast inserted, should cause the expansion of the carbonic acid gas contained in its vesicles, the consequent bursting of the same, and the liberation of the gas enclosed; and when such is effected and the separation and diffusion of the three substances throughout the wort is accomplished, and a subdivision of each substance into nucleus principles is performed; the affinity which exists between the atoms composing each nucleus, and the atoms composing the wort and the superincumbent atmosphere operates to effect by the power of attraction, a union or accretion of such atoms to the nucleus atoms; and thus a partial decomposition of the wort and atmosphere is effected; and the composition of carbonic acid and spirit and the coagulation of gluten is accomplished, the addition of such atoms to each nucleus, forming the increase by accretion of those substances which had been introduced in the compound substance termed yeast: the carbonic acid and coagulated gluten are both excretory substances and the spirit is the essence of a vinous fermented fluid; but neither the one or the other can be separated from the wort but by chemical or mechanical means, or conjunctively by both. To separate the carbonic acid from the wort subsequent to its formation, it is necessary to convert it into carbonic acid gas of a less specific gravity than the superincumbent atmosphere, by the addition of a sufficient quantity of heat to the carbonic acid; and the heat which is necessary for such a purpose is derived from the wort itself; for as in the formation of carbonic acid, both the oxygen of the atmosphere and the carbon of the wort unite, and each class of atoms quit their former situations and associate atoms, so do they consequently liberate all the atoms of heat, which previously formed a constituent portion of the atmosphere and wort thus decomposed, and which heat as a constituent portion of either fluid remained in a state of latency, during a continuance of the integral state of either: the integral condition of both fluids being destroyed to an amount proportionate to the quantity of carbonic acid generated, and a proportionate quantity of latent heat set at liberty and rendered free by such a process, such liberated heat combines with the carbonic acid, separates its ponderable atoms to a greater distance from each other and become constitutent associates with those atoms, and the whole together form a gaseous compound, denominated carbonic acid gas; and which gas being rendered of less specific gravity than the superincumbent atmosphere, it necessarily evolates from the upper surface of the wort and becomes the future tenant of the atmosphere. Nature having thus endued the atoms of oxygen and carbon with an affinity for each other; provided the means for their union by attraction; appointed a definite number of atoms of heat as their attendant constituent associates; and devised the measures for their conjunction: the carbonic acid formed in wort as an excretory substance, is expelled therefrom by its conversion into a gaseous fluid, lighter than atmospheric air. Nor has nature failed to provide the suitable means for the expulsion and separation of the other excretory product of fermentation, the coagulated gluten, but has rendered tributary to her purpose, the carbonic acid gas as a mechanical agent to assist in the accomplishment in a twofold way. Gluten being by the process of coagulation changed from a state of chemical to simple admixture with the wort, and being of greater specific gravity in such state than the wort, it would necessarily sink to the lower surface of the wort, and remain there as an excretory encumbrance, or as a subsequent ferment to induce a second foul fermentation should its fermentative powers be called into action by inciting circumstances: but nature ever prolific in ample resources for the accomplishment of all her purposes, has contrived, that an accretion of the gluten chemically mixed with the wort, should accrue to the nucleus atoms constituting the gluten inserted in a state of simple mixture in the wort as a constituent of yeast; and that the result of the union should be the formation of flakes of such a construction as to form vesicles for the reception of carbonic acid gas: the generation of carbonic acid gas and the formation of these flakes of gluten being a simultaneous operation, and occurring in every portion of the fluid in a state of fermentation, the vesicles formed by the flakes become filled with the carbonic acid gas generated, and thereby render those flakes specifically lighter than the wort in which they are formed, and consequently they rise to the upper surface of the wort, and are or may be, either ejected from the bunghole of the cask, or skimmed from the surface of the tun agreeable to human mechanical arrangements or operations.

Thus it will appear evident that nature on her part has provided all the necessary resources, and the needful means and materials for the accomplishment of fermentation on correct principles; and has left man the task of discovering what those resources, means, and materials are, and the way to appropriate them for the fulfilment of his purposes; and freely furnishes the knowledge of the use to such as diligently and skilfully search amidst her treasures for them.

The process of vinous fermentation is conducted by the brewer, distiller, and vinegar maker, influenced by one purpose as relates to the production of spirit; but each governed by a different motive as relates to the extent of such production, and its ultimate appropriation.

The brewer's purpose is to generate spirit to a limited extent, designing that such spirit should be consumed as a beverage, in conjunction with a portion of the unfermented extract obtained from the malt, and the menstruum by which it was dissolved, and endeavours to furnish a compound of such substances to his customers subsequent to fermentation, as will be composed of them in due proportions so as to satisfactorily gratify their taste. But the accomplishment of this task is by no means an easy affair; for in the first place among his customers there are a great diversity of tastes and opinions, some requiring more spirit, some more extract, and some more menstruum; and although he may have mentally classified his customers, conscious that he cannot please them all, and may have ascertained the prevailing taste of the majority, and be determined to endeavour to please them; yet will he find so many difficulties and opposing circumstances in his way, as will occasionally set at defiance all his endeavours to fulfil his purpose, however ably supported they may be, by knowledge, skill, experience, resources, necessary or remedial, and the best of materials to operate upon.

As illustrative of a portion of those impediments which may be found in his way, let us suppose that a brewer has discovered that a guile of beer which he has brewed gives more than usual satisfaction to the majority of his customers; and alive to the importance of the fact he immediately commences an investigation and enquiry as to the cause, being anxious to ascertain it, in order that he may in future endeavour to produce beer that is exactly similar, or as near like it as is possible. Beginning at the right end, he examines his malt and hops, but finds nothing peculiarly different in either as relates to quality or condition: he next examines his brewing journal, and finds that in the process of brewing his usual system was pursued: he knows also that the water used was derived from the same source as customary, and he is not aware of any variation in its quality or condition: he is fully aware too that the original density of the wort was of the usual standard: but he at last finds (for illustration sake) that such wort was attenuated much higher or lower than usual, and concluding therefore that such was the cause of the unusual satisfaction furnished, he next endeavours to discover why on this particular occasion the attenuation of his wort in the process of fermentation, should have proceeded to a greater or less extent than usual: and we will suppose that he really has discovered the cause, and that it was the pitching his tun at a higher or lower heat than usual, and he determines for the future to change his pitching heat to what he now deems the proper amount; does it follow that he will from such a circumstance always experience the same result? By no means! The varying temperature of the atmosphere and the quantity that may pass over his tuns during the continuance of his wort therein; the varying condition of the atmosphere as relates to the presence of oxygen, and the liabilities of such oxygen being imparted to his wort; the variable quantity and quality of the yeast he may administer, the variations in its temperature, in the mode, period, and circumstances of its impartation; and numerous minute circumstances that might be mentioned and occur during the process of fermentation in the tun and cleansing casks, may produce widely dissimilar results, in spite of knowledge, experience, care, and the most sedulous attention. But does it follow from this declaration, that knowledge, experience, care, and sedulous attention are of no avail? By no means! All that we contend for is, that one invariable pitching heat; quantity of yeast; period of continuance in the tun; time and circumstances of cleansing; mode of filling up cleansing casks; and other minutiæ that may belong to the invariable system, will not uniformly produce the same results even in following brewings, nor an approximation to uniformity in the course of a year's practice; and we are of opinion that the superintendant of fermentation should be as the pilot at the helm, capable of conducting his fermentations to the same point, as the other is to steer the vessel safely into port, under all the varying circumstances, difficulties, and opposing elements to which he is continually subject; guiding the helm agreeable to the dictates of knowledge and judgment, instead of pursuing an invariable system.

But the brewer's purpose is not only to furnish his customers with beer compounded of proper proportions of spirit, unfermented extract, and the dissolving menstruum; but also to supply it perfectly transparent, or free from the coagulated or chemically developed gluten, and replete with carbonic acid in a state of conversion into gas, by the process termed insensible fermentation, with the addition of any peculiarity of malt, hop, or aged flavor.

The motive of the distiller in the process of fermentation is the production of the largest quantity of spirit and the purest, at the least cost that is possible, consistent with excise restrictive regulations; and as the spirit produced is destined for consumption in a state of separation from the other substances from which and with which it is generated, he sacrifices all considerations as relates to their ultimate appropriation and value, for the paramount object of producing the largest amount of spirit. Nor is the distiller free from manifold difficulties, which are enhanced in magnitude and increased in number by various excise restrictions and duties, which compel him to the use of much raw grain instead of malted, and prevents the exercise of a free choice in the selection of materials, and of the judgment in the mode of their appropriation. Thus circumstanced he is compelled to perform in the fermenting tun by the process of fermentation that which should be performed in the malthouse by the process of germination—the conversion of gluten into fecula and fecula into saccharum. This onerous task imposed upon the distiller to suit the arbitrary regulations of a fiscal system, prevents the obtainment of so large an amount of spirit at a specific strength, or of so great a degree of purity as might be accomplished, as if left to the freedom of choosing his own materials and operating upon them agreeable to the dictates of his own judgment: as relates to the purity of spirit, there are a variety of substances that will yield a much purer spirit than even malted barley; but the use of unmalted barley involves the necessity of the wort being impregnated with the oleaginous or resinous cement of the skin, which in the steeping of barley for the purpose of malting is extracted and separated therefrom, and the fetor of which must be sufficiently obvious to convince those who are practically acquainted with its odour, that it must cause the liability of the purity of the spirit to be thereby affected. In addition to this cause, is the large amount of acetous acid which must be formed in a distiller's wort, subject as it is to so high and powerful a fermentation, and conducted as it is to an extremity of extent, in order to generate the greatest amount of spirit that their wort will yield; and the odour of a distiller's raw spirit that is the product of two or three consecutive distillations, will bear ample testimony to the amount of its impurity, without reference to the condition of the first product, or to the distiller's or rectifier's faints which are separated from the purest portion of the spirit on each distillation. The powerful and extensive fermentation to which a distiller's wort is subjected for the purpose of producing a large quantity of spirit, occasions the liability of a loss of a considerable portion of such as is generated, as the result of two causes, provided every necessary preventive precaution is not adopted;—the evaporation of a small portion as the result of the high fermentative temperature attained by the wort, and a large portion by its conversion into acetous acid, as the result of the impartation of oxygen beyond the amount of carbon in the wort to combine with it; the high temperature facilitating the impartation of oxygen from the atmosphere, and the early evolation of the carbon from the wort in the form of carbonic acid gas.

The vinegar maker also comes in for his share of difficulties in the process of fermentation, his present purpose being the generation and preservation of the largest amount of spirit that is possible, and his ultimate purpose the conversion of such spirit into acetous acid; and the difficulty he experiences in accomplishing both purposes satisfactorily, arises from the liability that his wort may experience a vino-acetous instead of a vinous fermentation in the first process. As his ultimate purpose is to effect an acetous fermentation, it may appear to those who are not well acquainted with the subject, a matter not only of little consequence if a vino-acetous fermentation instead of a vinous does occur, but a positive advantage; inasmuch as they may suppose, that thereby his ultimate purpose would be sooner and better effected; but however specious such an opinion or expectation may be, it is not so realized in practice, practical experience proving that such malt vinegar as is the produce of malt containing a large amount of saccharum, the wort from which has experienced a sound and extensive vinous fermentation, ultimately proves to be the strongest and best flavored; and the distillation of vinegar proves, that as it furnishes no spirit, and as it must be well known that the spirit which the wort had acquired during the process of vinous fermentation, cannot have evaporated during the process of acetous fermentation, to which such wort may subsequently have been subjected, so therefore it must necessarily be concluded, that the spirit generated has been converted into acetic acid: and if we examine the following statements of the analytical products of each,

	Alcohol,	Acetic Acid,
Oxygen	8 atoms	24 atoms
Hydrogen	3 „	3 „
Carbon	12 „	24 „
	23 „	51 „

we shall perceive that by the process of conversion the amount of hydrogen of each substance remains the same, but that the amount of oxygen is trebly, and the amount of carbon doubly increased; and from this fact we infer, that by the process of acetification, a very large addition of oxygen from the atmosphere, and carbon from the other substances composing the wort, is made to the oxygen and carbon composing the spirit; and that as spirit (alcohol) is composed of the same class of atoms as acetic acid, yet of a definite number of each, so any addition of atoms of oxygen or carbon to the definite amount of the respective portions constituting spirit, must convert a portion of such spirit into acid of a character ranging from the acetous to the acetic state, in proportion to the amount of the addition of both. From this view of the subject, the brewer may derive a most important lesson as well as the vinegar maker, the former perceiving the approximating resemblance between alcohol and acetic acid, both substances being composed of precisely the same classes of atoms and differing only in the proportionate amount of each, and how slight and indefensible is the barrier between the properties of the alcohol which constitutes the essence of his product, and acetic acid with all the gradatory points between, which constitute the baneful and injurious portion of an improperly compounded product; and the latter perceiving that as acetic acid is composed of the same class of atoms as alcohol, and only differs from it in the difference in the proportionate amount of the atoms of oxygen and carbon, so the generation of spirit is but the primary part of the process of acetification, to be followed and terminated by the process of converting such alcohol into acetic acid, by the addition of more oxygen and carbon to the pre-existing elements,

As the limits and purport of this work will not admit of justice being rendered to the subject of fermentation, the author must beg to refer the reader to his Theoretical and Practical Treatise on Brewing, for any further information which he may require.

FETID, ***stinking, rank, strong, offensive.***

All vegetable extracts are liable to a putrefactive fermentation, and the fetor most to be apprehended and dreaded in the brewery, is such as arises from the putrefactive fermentation of the wort in its fluid state, the extract of malt in a semi-fluid or dry state, yeast, beer grounds, &c.

The addition of a substance in a putrefactive state to wort, is sufficient to cause its putrefactive fermentation; and the fermentation of the wort, to cause a very considerable increase of the putrefactive principles, inasmuch as the putrefactive ferment being extensively and uniformly divided and diffused throughout the whole body of the wort, forms an assemblage of nucleus atoms, to which by the power of affinity and attraction, an accretion of such atoms from the wort occurs, as is necessary to constitute similar products to the putrefactive ferment introduced. The exposure of wort to the atmosphere for a long period, particularly in hot weather, without the addition of a vinous ferment, is often sufficient to induce a putrefactive fermentation; and the same observation applies to the extract of malt, yeast, &c. which adheres to the surface of vessels in which either may have been placed, and from which the bulk may have been withdrawn, leaving the dry extract of malt, or the solid gluten of the yeast, adhering to the surface subsequent to the evaporation of the fluid with which they were combined. The obvious preventive to such a liability, is the careful ablution of the surface of such vessels in a short period after they are emptied, with clean water.

The surface of such vessels whereon this putrefactive fermentation occurs, or such as contain a wort that is in, or has been in a state of putrefactive fermentation, become tainted in proportion to the porosity of the material of which they are composed; for in proportion to the depth that the fetid fluid or extract is able to penetrate into the material of which the vessel is formed, so must the quantity of the fetid material be that is left in the material composing the vessel, after such fluid is withdrawn; and as there is no affinity between water and the putrefied extract that has entered into the pores and cavities of the vessel, so no ablutions of water, however frequently repeated, are sufficient to withdraw the fetid material from the vessel which has become tainted. Hence it is evident that some fluid is necessary, and its mode of application such, that it will enter into the pores and cavities of the material of which the vessel is composed as deep as the fetid extract has penetrated, and between which and such extract there is a chemical affinity, which will cause a solution of the extract, and a neutralization of its fetor.

In the obtainment of such a fluid there are two considerations involved—an effective power to accomplish the purpose, and of small cost.

There are disinfecting fluids such as chloride of lime, &c. which are not too costly for a brewer's use, provided he cannot meet with any other as effective, and much cheaper; as the continuance of the fetor in a public brewery would be incompatible, and the cost of disinfecting would be preferable to the destruction of the vessel. But a more effective and infinitely less costly fluid has been long used by the author for the purpose of disinfecting vessels tainted with fetor resulting from putrefactive fermentation, (technically called the fox) or with must, rancidity or any other taint resulting from atmospheric influence; and is equally effective in seasoning new casks or utensils by abstracting the tanin from the pores of the wood.

FLAT, *dead, spiritless, vapid, &c.*

Water deprived of its carbonic acid by boiling, drinks flat and insipid, and is therefore not grateful to the taste; and the same observation applies to beer which has lost too much carbon by the process of fermentation, and therefore does not possess enough to unite with the oxygen imparted to the beer from the atmosphere, so as to form carbonic acid gas, sufficient to furnish that lively, sprightly, pungent action on the palate, which is ever agreeable to the consumer.

One of the purposes of fermentation should be to leave a sufficient quantity of carbon in the wort after the first and foul fermentation has ceased as will unite with all the oxygen imbibed by such wort or beer, during the period of its keeping for, and the time of its consumption; and to accomplish such a purpose, the first section of fermentation must cease before all the fermentable material of the wort is decomposed; and the endeavour should be, by a gentle and slow transparent fermentation in the second stage, to furnish to the consumer beer which is replete with carbonic acid gas at the time of consumption. Nor is it alone necessary, to leave a sufficiency of carbon for the gradual and continual production of carbonic acid gas during the period of storing for sale, and its draught for consumption, but favorable circumstances for the suitable production and retention of such gas are necessary; and hence the necessity of a nice and skilful regulation, so that the creation and retention of such gas may not cause a second foul fretting, or acetous fermentation; for as the decomposition of the remaining portion of the fermentable material is the result of the second fermentation, if such decomposition is too rapid, the glutinous excretory products will not have time to subside to the bottom of the cask as fast as they are coagulated; and if the carbonic acid gas is too powerfully restrained it will cause that intestine motion in the beer, as will cause the suspension and diffusion of the glutinous excretory products throughout the body of the beer, and thereby render it a foul instead of a transparent fermentation.

FLAVOR, *a taste, relish, scent, smell.*

To discover a correct standard whereby to measure the public taste would be as fruitless an endeavour as to attempt to find out the true colour of the cameleon.

The brewer must regulate his attempt to please his customers by general rules. As relates to the flavor of his products, there must be the entire absence of fetor, of extreme mawkishness, of great acidity, the presence of an agreeable aroma, an acidulated sweetness, and a grateful pungent stimulus to the palate.

To accomplish this, a scrupulous attention to cleanliness and purity of water is needed; and malt of the best quality, and hops possessing a fragrant aromatic oil, with yeast of good quality are necessary as the ingredients; a proper method of extraction, a suitable time of boiling, and a correct mode of fermentation, are the requisite components of a good system of brewing; the subsequent storing, racking, mixing, fining, and delivery on correct principles constitute the suitable preparation for consumption; and the skilful management in the cellar of the consumer or his superintendant, forms the final addenda to a successful practice, and the fulfilment of all the conditions to ensure satisfaction.

FLUID, *flowing, running as water, melted, soft.*

A fluid may be termed an intermediate substance between a solid and a gaseous body, possessing a greater portion of the imponderable atoms of heat mixed up with its classes of ponderable atoms, than is blended with the ponderable atoms in a state of constituent admixture, of which a solid is composed; and a less number than constitute the component portion of a gas or vapour. Thus the constituent atoms of ice, water and steam, are the same as relates to the classes of atoms, both ponderable and imponderable; but the difference in the constituent amount of the imponderable atoms of heat of each body or substance, furnish the several properties and characteristics for which each are distinguished. Impart heat to ice, and you convert it into a fluid; continue the impartation to the fluid and you transform it into a vapour; retrace the process and abstract heat from the vapour, and you reduce it to a fluid, continue the abstraction and you render it a solid. And this vast, immeasurable power is entrusted to God's vicegerent, man! And the knowledge and application of its use, is the cause of the formation and diffusion of countless agencies administering to the necessities, the comforts, and the luxurious indulgences of his fellow man.

The properties of a solid consist in the close contact, adhesion, and the immobility of its constituent imponderable atoms. The motion of the one is the motion of the whole, as the force impinging against one or more of the constituent ponderable atoms is transmitted to the whole, effecting the movement or vibration of the whole.

The properties of a fluid consist in the freedom from close contact, the non-adhesion, and the mobility of the constituent atoms among themselves. The motion of one atom is not the motion of the whole, as the force impinging against one or more of the constituent atoms is not transmitted to the whole, therefore it does not effect the movement or vibration of the whole.

The properties of a vapour or gaseous body consist in the freedom from close or contiguous contact, and the mobility of its constituent atoms among themselves; nor does the force impinging on one or more of its constituent atoms cause motion or vibration to the whole.

A solid is compounded of a definite proportion of two or more classes of ponderable atoms, and one or more classes of imponderable atoms; the ponderable atoms being closely united by the power of attraction of cohesion, and the imponderable atoms residing in the interstices presented by the union of the ponderable atoms. A fluid is compounded of a definite proportion of two or more classes of ponderable atoms and one or more classes of imponderable atoms; the ponderable atoms not being in close contact, or held united by the power of attraction of cohesion, but are held in proximity by the power of attraction of aggregation: and the cause of their not being in close contact, is the result of the presence of more imponderable atoms than the interstices which would be presented were they so, would contain, hence they are necessarily kept apart, and thereby possess the power of mobility among themselves.

A vapour or gaseous body is compounded of a definite proportion of two or more classes of ponderable atoms, and one or more classes of imponderable atoms; the ponderable atoms being situated at a much greater distance from each other than are those of a fluid, but are yet held in unison by the power of attraction of aggregation; and the cause of their not being in close or proximate contact, is to be attributed to the presence of a much larger amóunt of imponderable atoms than enter into the composition of a fluid, but yet not so large an amount as to place them beyond the sphere of the power of attraction of aggregation.

The constituent ponderable atoms of solids, fluids, and vapours or gases, are subject to the laws of affinity, simple and aggregate, and cohesive attraction, and gravity; and the constituent imponderable atoms to the laws of equal diffusion and recession.

Affinity is the motive, disposition or desire, which induces two or more atoms to unite: simple attraction is the power by which two or more atoms are enabled to unite, although they may be placed at some distance from each other. Aggregate attraction is the power subsisting between two or more atoms already united and other atoms in a state of freedom, by which the latter are enabled to unite with the former. Cohesive attraction is the power by which atoms are not only able to unite in vicinity or proximity, but in close contact, and so to remain united until disunited by a superior power. Gravity is that power by which the ponderable atoms fall toward the centre of the earth, each being endued with the power of affinity, simple, aggregate, and cohesive attraction, and therefore ever influenced by a desire and a power to unite not only with each other, but the nucleus atom of the earth. Equal diffusion is that power by which the imponderable atoms are invested, or that desire and ability to be every where present to an equal amount, and therefore are constantly liable to motion or transmission from one body to another, to maintain that state of equality when and wherever it shall be disturbed. Recession is that desire and power with which the imponderable atoms are endued, to recede from the centre of the earth.

The law of equal diffusion to which the imponderable atoms are subject, is superior to the law of recession to which they are subject: and the laws of equal diffusion and recession are superior to the laws of affinity, simple, aggregate and cohesive attraction, and gravity to which the ponderable atoms are subject.

The law of gravity is superior to the law of cohesive attraction; cohesive attraction to aggregate attraction; aggregate attraction to simple attraction; and simple attraction to affinity.

Solid, fluid, and gaseous bodies being compounded of ponderable and imponderable atoms, each being subject to diverse and opposing laws, possess certain properties and characteristics resulting from the classes of atoms, the proportion of the classes, and the arrangement of the classes of ponderable atoms, and the classes, proportion and arrangement of the imponderable classes, as well as the predominance in the proportion of the imponderable and ponderable atoms of which they are composed: thus the properties and characteristics of water in the form of a solid, (as ice) results from the combination of a definite proportion of the ponderable atoms of oxygen and hydrogen and the imponderable atoms of heat; —of water as a fluid, from the combination of the same proportion of the ponderable atoms of oxygen and hydrogen with a much larger proportion of the atoms of heat;—and water as a vapour (steam) with a yet very much greater proportion of the atoms of heat.

The specific gravity of different fluids are various, and the specific gravity of the same fluid, may be increased or diminished by the impartation or abstraction of free or active heat to or from such fluid.

The cause of the difference in the specific gravity of various fluids, arises from the difference in the proportion of the ponderable to the imponderable atoms of which they are respectively compounded; the specific gravity of such fluids as possess the largest amount of ponderable atoms in an equal bulk being the greatest.

The constituent amount of atoms of heat appertaining to any fluid, is not a definite or standard amount, as it is ever liable to an addition by the impartation of heat from bodies in contact or vicinity, or to a diminution by the abstraction of heat therefrom by bodies in contact or vicinity; and therefore the constituent amount of heat appertaining to any fluid, may be said to be any possible amount between the conversion of such fluid into a vapour or a solid.

Whatever may be the amount of the constituent atoms of heat of a solid, fluid, or gaseous body, those atoms are in a state of latency or quiescence, provided those bodies in contact or vicinity, possess a proportionate amount of heat in a state of constituency; but should an abstraction of heat from any body in contact or vicinity be effected, then will as much of the latent or quiescent heat in that solid, fluid, or gaseous body as is necessary to restore the equilibrium, be rendered active, and pass by transition to the body from which the heat was abstracted: or should an impartation of heat occur to the body in contact or vicinity, then will as much heat pass by transition from such body to the solid, fluid, or gaseous body, as may be necessary to increase the amount of its constituent heat to an equilibrium with the body in contact or vicinity.

The increase or decrease in the bulk of a solid, fluid or gaseous body, by the impartation or abstraction of heat, is termed expansion and contraction.

The bulk of a fluid cannot be dininished by pressure, because its constituent atoms do not cohere, and therefore they are subject to mobility in every direction; and because their proximity is such, that they touch although they do not cohere; and being spherical, any force applied to one or more of the constituent atoms, causes the displacement of all those to which the force extends in every direction.

The ponderable and imponderable atoms cannot cohere, although they may be in close contact, inasmuch as they are not united by the power of simple, aggregate or cohesive attraction, nor does any affinity subsist between them.

The pressure of a fluid upon an orifice in the bottom or side of a vessel is not in proportion to the quantity of the fluid within, but to the altitude of the fluid above the orifice; for as the pressure of a fluid is in every direction, so the pressure upon the orifice is in proportion to its area, and the altitude of the fluid above it: thus if one vessel contains a ton of water and another but one hundred weight, and the orifice in the bottom or side of each, is of the same area, and the altitude of the fluid above the orifice in both vessels is the same, then will the pressure upon the orifice of each be precisely the same, and as much water will run out of the smaller vessel as the larger, in the same given time, provided the same altitude in each is preserved by impartation, corresponding with the amount of the quantity abstracted.

The immersion of a solid body in a fluid, will displace a quantity of such fluid, proportionate to its bulk; and the weight of the fluid displaced, and the body immersed, determines the relative specific gravity of each.

Thus if a vessel is accurately filled with distilled water, and a cubic inch of iron or any other substance is carefully immersed in such water, a cubic inch of water will flow from the vessel, and such displaced water and such cubic inch of iron or any other substance, being weighed in accurate scales in air, the specific gravity of such iron or other substance in relation to the gravity of the water will thereby be ascertained.

FURNACE, ***an enclosed fire place.***

The construction of a furnace on correct principles is a matter of much importance to a manufacturer, as relates to the economy of consumption of fuel, and the purpose for which it is consumed; and the aid of science in devising the suitable construction is both felt and acknowledged as highly necessary by the intelligent proprietor or superintendant.

The various purposes for which furnaces are constructed, require a great diversity in the mode of construction. The description of fuel to be consumed, the intensity of the heat required, the requisite promptitude of its impartation, and the economy of its production and appropriation, are the principal considerations to induce the primary attention to that form and size of furnace, the requisite appendages, and the details of construction which are best calculated to effect the desired purpose: and as it cannot be supposed that the bricklayer ought to know the purpose of the manufacturer as well as himself, the latter should define to the former the several purposes which he wishes to be accomplished, and the former should know how to fulfil the wishes of the latter.

As oxygen supports the combustion of the fuel in the furnace, and the atmosphere furnishes the most economical and convenient supply, the first consideration in the construction of a furnace is, to ensure an adequate supply of atmospheric air to maintain the combustion, and to provide means for its suitable access thereto; and the customary medium of access is the ash pit, and the interstices between the bars on which the fuel is placed.

Furnace.

The furnace bars, on which the combustion of the fuel occurs, receives a large amount of heat from the fuel, and much of that heat is imparted to the air within the ash pit by radiation from the bars, and such air is thereby expanded, and rendered specifically lighter than the air without and above the orifice of the summit of the chimney, and therefore it ascends and passes through the fuel with a force and rapidity, proportionate to the difference in its specific gravity and that of the external atmosphere; and in its passage through the fuel it is decomposed, its oxygen uniting with the carbon and hydrogen of the fuel, and therewith forming carburetted hydrogen gas, which evolating from the fuel, accompanied by the heat which is liberated and rendered active by its decomposition, the products of combustion are conveyed to the flues, and from thence by the shaft of the chimney to the external atmosphere.

And it is this heat which is thus liberated from a state of latency in the fuel by its decomposition, and being liberated unites with the carburetted hydrogen, and thereby converts it into gas, and which unites also with the other excretory products of the combustion of the fuel, and the nitrogen of the atmosphere, which the manufacturer has to arrest a portion of, in its rapid transition from the furnace to the external atmosphere, above the orifice of the summit of the chimney; and to appropriate it by abstraction from those products, and by impartation to the contents of the vessel placed over the furnace through the material of which the vessel is composed; and to effect the abstraction and impartation in the most advantageous way, as relates to the several purposes which each manufacturer may have to accomplish, there are a variety of considerations which induce a peculiarity of construction of the furnace, the vessel or other receptacle of heat placed over it, the flues, chimney, &c. with a view to ensure the best fulfilment of each process, which the aid of heat is necessary to effect. As the maltster's purpose is not to consume fuel, for a direct impartation of the resulting heat to the grain on the kiln, but to raise the temperature of an immense body of air, in order to render it more fit to part with its oxygen, by transition to the grain, and to decrease its specific gravity in order to cause its ascension and passage through the perforated floor and the grain thereon, as a necessary condition to ensure the impartation of the required oxygen, and to cause an evaporation of the water contained in the grain, by its conversion into vapour, resulting from the impartation of heat thereto from the atmosphere; so is it necessary that in the construction of his furnace, a due attention should be paid to the admission of a sufficient supply of air to the kiln furnace room; to the access of a sufficient quantity to the fuel to support its combustion through the ash pit and furnace bars; and for the passage of as much air over the fire, and through apertures adjoining the cheek plates of the furnace, as may be necessary to effect the required impartation of oxygen and heat to the grain, to ensure the successful accomplishment of the processes of saccharification, evaporation, colouring and flavoring. It is usual therefore in the construction of kiln furnaces on the best principles, to provide for the free and unrestricted access of as much air to the fuel and the grain through the ash pit and furnace bars, above the furnace bars and between the fuel and the crown of the furnace, and through an aperture at each side of the cheek plates, as the most intense heat which can be generated by combustion in the furnace, will cause to circulate and pass from the kiln furnace room through the grain on the kiln floor: and having provided the means of access for the greatest supply that can be needed, it is also necessary to furnish the required means to regulate the supply to an amount and velocity agreeable to the judgment of the maltster, for which purpose the apertures at the sides of the furnace cheeks should be furnished with dampers, and the furnace and ash pit with doors to regulate or cut off the supply of air, as may from time to time appear necessary.

The brewer's purpose is to cause the combustion of fuel to liberate its latent heat, and to cause its impartation to the water or wort in a vessel which contains it; and as such heat is first imparted to the air which passes through the fuel, and the gaseous products of combustion, as well as the materials of which the furnace, &c. is composed; and as such air and gaseous products are rendered specifically lighter by the impartation of heat thereto, and to an extent proportionate to the amount of heat imparted; so is the rapidity of the transition of such air and gaseous products from the fuel to the chimney summit, proportionate to the decrease of their specific gravity resulting from the impartation of heat; and hence the rapid liberation of heat by combustion, is inimical to its economical appropriation.

As the provision made for the liberation of latent heat by combustion, includes the arrangements necessary for its evolation, and as the velocity of the evolation is proportionate to the rapidity of the liberation; so is it requisite that all the arrangements of the brewer, for the abstraction and impartation of such heat from the conveying medium to the water or wort in the vessel, should be made with judgment and skill, to ensure the needful economy in the appropriation, consistent with a sufficient rapidity of impartation.

The conditions connected with the appropriation of heat liberated by the combustion of fuel, in the most economical way, are a sufficiently extensive horizontal surface of metal, of the least suitable thickness, and the best conductor of heat, to receive as much heat from the decomposed air and gaseous products of combustion, as will leave but enough to render their specific gravity such as will enable them to travel from the fuel to the terminus of the chimney; but as vessels constructed upon the best principles for the economical appropriation of heat, would neither suit the chemical or mechanical requirements of the brewer, it is desirable that he should endeavour so to blend the claims of each, as to be able to derive the greatest advantage from a due attention to them collectively, in the construction of his boilers, furnaces and their appendages.

GAS, *subtle spirit*, *light stream*, *rarefied vapour*.

The earth is surrounded with a thin subtle fluid called air or atmosphere, which is of less specific gravity than anything appertaining to the earth, whether solid or fluid, in its natural state. But solids and fluids may by decomposition and the impartation of heat to their constituent atoms, be converted into thin and subtle vapours, some of less and some of greater specific gravity than air, and such as are lighter will ascend in such air, until they attain to a height where the specific gravity of each are equal; and will remain suspended therein until the abstraction of any portion of that heat which has rendered a solid or fluid gaseous, diminishes its specific gravity, when it will descend to a lower strata of air, and which is of the same specific gravity; and should it happen that all the heat imparted to the solid or fluid to render it gaseous are withdrawn; then the constituent atoms of which such solid or fluid was originally composed, will descend to the earth again; and although they may not unite together in the same order of arrangement, as they subsisted in the original body, yet will they become the component atoms of some terrestial bodies, as may be induced by the power of affinity and attraction operating upon them during and subsequent to their descent, or become the nucleus atoms of new bodies.

Thus ice or water by the impartation of heat may be converted into a vapour, and such vapour being a compound, composed of the constituent atoms of ice or water, and the atoms of heat imparted, and being as a new body of less specific gravity than the surrounding air, it ascends, and attains to such a height as where the specific gravity of both are equal; and such vapour may form a portion of a cloud or otherwise, and will remain suspended at various altitudes, as the abstraction of heat therefrom or impartation thereto may vary, until an abstraction of heat occurs, sufficient to allow the atoms of oxygen and hydrogen to approach each other in proximity or close contact, and thereby constitute mist, rain, snow or hail; and in either state being of greater specific gravity than the atmosphere, are precipitated to the earth with a velocity proportionate to the difference in the specific gravity of either, and the atmosphere through which they descend, and the height from which they fall.

The gaseous products of solids in a state of inflammable, fermentative, or other decomposition, are some of less, and others of greater specific gravity than atmospheric air, when both are of the same temperature.

Two of the four distinct species or classes of ponderable atoms which are best known, and the properties of which are best understood, and of which the majority of solids and fluids are composed, are when mixed with atoms of heat to a sufficient extent to form together a gaseous compound, lighter than air, and the other two are heavier: the lighter gases are known by the name of hydrogen and nitrogen gases, and the heavier by the names of oxygen and carbonic acid gases. The three first named gases are compounded of each distinct class of atoms and a definite quantity of heat; but the latter of definite proportions of oxygen and heat; while no gas compounded of carbon and heat alone, has yet been procured by chemical manipulation.

Although oxygen gas, and carbonic acid gas are heavier than atmospheric air, each being of the same temperature, yet the specific gravity of those gases may be rendered less than air, by the impartation of a sufficient quantity of heat; and either of these gases emanating from a solid or fluid in a state of inflammable or fermentative decomposition, possess a sufficient quantity of heat as to render them lighter than atmospheric air, in the vicinity of the earth; and in proportion to their specific gravity is the altitude of their ascension, and to other causes is to be attributed the extent of their diffusion throughout the atmosphere: and as the total or partial decomposition, and the total or partial recomposition of bodies are principally, if not entirely the result of the power of affinity existing between the atoms of carbon and oxygen; the superior specific gravity of these gases to atmospheric air is another proof of the admirable arrangements of providence, whereby the ponderable atoms most needed for the operations of nature and of art, are placed within the sphere of simple, aggregate and cohesive attraction.

Although the atoms of oxygen are subject to the law of gravity, and consequently have a tendency to fall to the earth, and oxygen gas is heavier than atmospheric air, yet it is more extensively and abundantly diffused throughout the atmosphere than any other species of atoms; and another instance of the admirable mode by which the diffusion is facilitated and effected may be mentioned, in pointing to the fact, that an immense quantity is imparted to the atmosphere by transpiration from the surface of the leaves of trees, &c. and the altitude at which such transpiration occurs; the heat imparted by the sun to the circulating sap, which facilitates and promotes its disengagement; and the liberated latent heat resulting, combine to occasion a more lofty diffusion of oxygen, than can well be effected by any process of decomposition at or near the surface of the earth. Another evidence of skilful contrivance to effect the diffusion of oxygen throughout that portion of the atmosphere adjacent to the earth, where vegetation scantily occurs, is the stormy blast or hurricane that succeeds a sultry period, when the transpiration of oxygen has been most abundant in consequence of excessive heat, and has attained to an unusual altitude from its admixture with so much heat, and which conveys and diffuses it in its swift career, throughout every region to which its course extends.

The transpiration of oxygen gas from the surface of leaves, &c. is to the brewer a subject of the first importance, whether the habits and tastes of his customers require that he should brew at such a period of the year, when vegetation is in the greatest state of activity, or whether he is enabled to discontinue the process during so critical and dangerous a period; for although he is far more liable to all the ill effects which may result from too great an impartation to his worts, if brewing at such a period; yet is he also liable to an acetification of his stock of store beer, by the impartation of too much oxygen from the atmosphere, which at such period so extensively and abundantly pervades it.

Carburetted hydrogen gas, from its extensive utility in furnishing a brilliant and economical light; from a well founded hope that by the further aid of science, it may shortly be appropriated as an advantageous motive power; and from the probability that a method will be discovered, whereby brewers may generate their own gas, appropriate it as a motive power, and without additional cost for fuel, heat their mashing liquors and boil their worts; merits in this work, a brief notice of the principles upon which it is formed, and upon which its combustion is effected.

The creation of carburetted hydrogen gas, is generally effected by the distillation of coal. The vessel used for the purpose is called a retort, and is made of cast iron or other material. Its shape is generally cylindrical, and is of varying length and diameter: it is hollow with one open end, to which is affixed a close fitting door; the other end is cast solid with the cylinder, but near such end is an orifice in the periphery, through which the gas resulting from the distillation, is conveyed by a pipe to the purifying vessel. The one or more retorts are fixed in brick work, over a furnace, without the open end projecting without, and parallel with the brick work; and the other end, including the gas conveyance pipe is enclosed in brick work beyond the furnace. This retort is nearly filled with coal, the cover put on, luted and fastened by a cross bar: a fire is then kindled in the furnace, (the fuel generally consisting of coal) and the retorts are made red hot, which causes an ignition of the coal within, and the distillation then commences, and the gaseous products passing through the orifice in the periphery, are conveyed by the connecting pipe to the purifier.

The gaseous products consist of carburetted hydrogen, mixed with tar, oil, ammonia, &c. in a state of vapour; the latter of which are condensed in their progress through the conveyance pipe, in which is inserted at suitable distances, descending pipes, which convey the liquid products into reservoirs, leaving the gas to proceed to the purifying vessel, which contains lime in a dry state, or mixed with water; and a chemical affinity existing between the lime and certain substances yet remaining mixed with the gas and which render it impure, a combination of them with the lime occurs, leaving a purer gas to proceed from the purifying vessel to the gasometer, which is a vessel immersed in water, to which the gas is conveyed as the final reservoir of supply to the conducting pipes leading to the various burners for consumption. To return to the retorts. As soon as the whole of the gaseous products have left the retort, the cover is taken off, the content consisting of coke is withdrawn, a fresh charge of coal is thrown in, and the former process is repeated, until the gasometers are charged with gas to the required extent. The difference in the mode of the combustion of the coal within the retort and without, consists in the access of oxygen by medium of atmospheric air to the latter in the furnace, and the inaccessibility of oxygen to the former in the retort, with the exception of the small quantity contained in the air which is in the retort when it is charged; and hence the difference in the extent of combustion, and the properties of the residuum, the ashes from one being of little value, or no value as fuel, and the coke from the other being of considerable value as fuel, for a second process of combustion in the furnace. The loss of an immense quantity of heat in the production of carburetted hydrogen gas in consequence of the manufacturer having no useful purpose to appropriate it to, appears to be a matter of regret; and should means be devised to appropriate carburetted hydrogen gas as a motive power by combustion, and the heat resulting therefrom appropriated to some useful purpose, as well as the large quantity of heat which is now wasted in the production of such gas, its manufacture in factories where much power, heat and light is required, will most probably be adopted.

GAUGING, *the act or art of measuring vessels.*

Every maltster and brewer will find it both desirable and profitable, to know and understand the art of gauging to an extent sufficient to enable him to determine the proper dimensions of a steeping cistern, for the purpose of steeping any definite quantity of grain ; the dimensions of the couch to receive it after it is steeped; the dimensions of the working floors that may be necessary to work off any given quantity of grain at the least depth that may be requisite during the season; and the proper dimensions of the kiln floor to dry in moieties or thirds, the proceeds of each steeping.

In the brewery it will be found advantageous to understand the art of gauging the several utensils used, and the full and ullage content of casks: and for the purpose named, a few plain and simple rules will be found sufficient, without the necessity of acquiring an extensive or complete knowledge of the art.

GENERATE, *to beget, produce, propagate, cause.*

The process of malting and brewing may be termed generative, the purport of each operation being to create new and artificial compounds from natural and simple materials. The first process is subsidiary to the second, and consists in converting grain of natural growth into malt of artificial production, impressing into the service the natural elements—water and air; copying nature in the process of germination, and stopping short of vegetation by the assistance of art, and breaking the gradatory link between each, by the power of imparted heat on the kiln. The second process may be considered as a continuation or secondary stage of the first, having for its purpose the blending of the soluble materials of malt with water by solution, and creating a new compound called wort: and by a third process—the fermentative, converting the sweet and double compound into a triple, susceptible of separation into a spirituous, aqueous, and solid subdivision.

The extensive powers entrusted by him, who "made man in his own image," to his creature man, are but little known, felt, appreciated and understood by those who are daily performing many stupendous operations, which they are permitted to accomplish; because they look not to the author of the gifted power, are unconscious of the importance of the act, and are but the insensible, controuled, and thoughtless imitators of the omnipotent and omniscient being who bade them learn thus far and no farther. The generative power entrusted to man, accompanied by a competent knowledge of the principles upon which that power is wielded, may truly be termed godlike; and the humble agent to whom it is delegated, with all its limitations, has much cause to be grateful to the giver of the gift; and viewing the magnitude of the raylike portion that irradiates the mind of each, with the illimitable and splendid source from which all knowledge emanates, well may the most ample possessor with humility exclaim

> How small the wisdom of the wisest man,
> Compared with His, who drew creation's plan.

In the exercise of a delegated generative power, imitating the process of (what is termed) nature, by the operations of art: a most important, skilful and scientific work is entrusted to the performance of the maltster and brewer: and although daily accomplished by men of no talent, and possessing but little knowledge, and yet whose operations often prove both favourable and successful; still if such results are not fortuitous, yet is the skill of such practitioners but imitative and not original; and compared with the practical results induced by the perceptions of a well grounded theory, their measures are but as the unmeaning phraseology of the imitative bird, compared with language dictated by the human mind: and as the utterance of words conceived by an intelligent intellect, convey information as far superior to the senseless expressions of irrational instinct; and as the light of the sun exceeds the reflected rays of the moon, so does the exercise of a generative power, resulting from a comprehensive knowledge of the subject, as much excel the imitative performance of the ignorant practitioner.

That as a general rule, both maltsters and brewers are mere copyists, is a self evident fact that will not admit of disputation; and in proportion to the value of the original system which it may be their chance to have the opportunity of imitating, and to the assiduity and ability of the imitator, so is the value of the transcript.

The generative theory of malting is to convert a portion of the solid materials of a grain of corn into a gaseous fluid; causing it to exude through the skin, and to be transfused throughout the atmosphere, and to cause the accretion of other atoms to those which are retained, dissimilar to those which have escaped, and thereby to create a new compound called malt. And the generative theory of brewing is to convert a portion of the solid materials constituting a grain of malt, into an aqueous fluid by solution in water, and thereby create a double compound called wort; and subsequently convert such double compound into a triple, by an abstraction of a portion of the constituent atoms of such double compound; and by the impartation of a dissimilar species of atoms, create the triple compound called beer.

GERMINATE, *to sprout, shoot, bud, put forth.*

The wise and beneficent author of all things, hath ordained that every seed shall possess the innate principle of life, and the power of producing its own similitude or kind, subject to a variety of conjunctive circumstances that are necessary to develop, and impel into action the vital principle, and accompany it to maturity and final extinction, as a cause, yet productive of an expansive effect, increasing in extension, proportionate to the ratio of reproduction. Thus the single grain of corn is imbedded in the earth, its vital principle is called into action, the process of germination is completed, vegetation commences, and soon the stalk is seen to protrude through the surface of the field, and slowly rising, puts forth the blade, the blossom, and the ear; and having attained to maturity, and produced its own kind with a manifold increase, the vital principle that hovered round the root, ascended the stalk, and pervaded each resemblance of the original, loses its activity, and dormant lies within the ripened grain, again to be awakened in reproduction's future process.

Germination is the first stage of vegetative growth, the defined limits of which may be said to be marked, as relates to barley, by the protrusion of the plumula or acrospire from the opposite point of the grain, to that from which the root proceeds.

The body of grain consists of two essential parts, the germ or small bud, and the cotyledons or seed lobes.

The first is the part endued with life, and the rudiment of the future plant; and the second the depositary of nutritious matter, such as the germ in a state of growth requires; and which nutriment is conveyed to it by slender vessels, which ramify through the whole body of the grain, as veins convey the blood throughout the animal system. In the germ, two distinct parts are discernible; the radicle, which descends from the seed, forming the root; and the plumula or acrospire, forming the stem.

When the solid is placed in the earth, or in other situations favourable to its growth, it absorbs moisture and swells, the radicle begins to shoot out, and at the same time the substance in the seed lobes suffers a change in its qualities, the fecula of which it consists being converted into sugar, which serves as food to the infant plant.

Thus grain possessing all the germinative functions, needs an accretion thereto, to call into action the vital principle, and an abstraction therefrom to remove the impediments to its progress and continuation.

The elongation of the radicle and the plumula, and the conversion of fecula into saccharum, are indicative proofs of the process of accretion; and (omitting other testimony) the difference in the weight of malted and unmalted grain, proves that abstraction has occurred to a much greater amount, than accretion in the process of germination.

The apparent first cause of germination is water, but water in a state of entirety is not the real cause, but the oxygen which forms the chief and most abundant constituent principle of water.

Grain placed in contact with or immersed in water, will imbibe a considerable portion of such fluid, the accretion causing a considerable expansion of the interior component materials and distension of the skin—a necessary preliminary to the process of impartation, and abstraction consequently resulting.

Such expansion and distension may be termed a mechanical process, to facilitate the subsequently chemical; the mechanical effect being induced by a chemical cause.

Water having penetrated to the germ, an accretion of oxygen therefrom results, induced by the affinity subsisting between it and the carbon of the germ, and its elongation ensues, which is termed the vital action, and is continued in proportion to the amount, rapidity, and temperature of impartation. A combination of the oxygen of the water with the carbon of the fecula also occurs, and such union effects a liberation of latent heat, which, combining with the double compound, called carbonic acid, forms a triple called carbonic acid gas: and the addition of the latter being sufficient to render such compound of less specific gravity than the surrounding atmosphere, its evolation occurs, and the needful abstraction of carbon is thereby effected. In the process of germination, therefore, the impartation of oxygen by the medium of water, is for the purpose of adding to the bulk of oxygen, which forms one of the constituent class of atoms of grain in its state of vital dormancy, and to abstract a portion of the carbon which forms another constituent class of atoms; the purport being the impartation of a sufficient portion of oxygen and the abstraction of a sufficient quantity of carbon, to furnish new properties and transmute original substances.

The atmosphere, as an additional medium of supply of a considerable quantity of oxygen, and as the recipient of the carbonic acid gas which is evolated during the process of germination, is an important yet a secondary agent in the operation; acting as an active or slothful auxiliary, in proportion to its temperature, and the quantity of oxygen and vapour held by it in simple combination, and the quantity and rapidity of its access as allowed by the maltster, or adventitious causes.

GLUTEN, *a glutinous, or sticky and tough substance.*

Gluten is a component substance of grain and a variety of fruits.

The ultimate principles, or classes or species of ponderable atoms of which gluten is composed, as furnished by analysis, are oxygen 22,00. Hydrogen 7,80. Carbon 55,70. Nitrogen 14,50 parts.

Gluten is compounded of the same classes of ponderable atoms as fecula, gum and saccharum, in different proportion with the addition of nitrogen, which furnishes it with distinctive and characteristic properties as a substance.

Gluten in solution, will not pass into a state of vinous fermentation owing to the presence of nitrogen.

Gluten in a state of solution with fecula, gum, and saccharum (as in wort) is coagulated by boiling and fermentation, and is in both cases ejected from the wort, and such coagulation and ejection is proportionate to the rapidity, continuance, and circumstances of either process.

Extracts from some fruits and vegetables possess a sufficient quantity of gluten to cause, promote, and continue the process of vinous fermentation without the addition of any vinous fermentative substance.

Gluten as a substance is not alone adequate to cause or promote vinous fermentation, but as in conjunction with, and as the medium of the impartation of the carbonic acid gas, contained in innumerable vesicles formed by the conjunction of the coagulated flakes into one general mass, and which rising to the upper surface of the wort in a state of fermentation, and covering such surface as a membraneous net work, arrests the carbonic acid gas in its exit from the wort, and by the upward pressure of such gas, and the elastic tenacity of the gluten, the innumerable vesicles are formed and the gas enclosed and secured for its retention and preservation, until needed as a vinous ferment by impartation to other wort. But so active and powerful a substance as carbonic acid gas, (its activity and power being induced by affinity and the impartation of heat) is not long or easily retained by so frail a material as the glutinous vesicle, which bursts upon the slightest pressure, or on exertion of the power of affinity existing between such gas and any substance that may be situated in vicinity, or the expansion of such gas, resulting from the impartation of heat from the surrounding atmosphere, &c. and thereby liberates its imprisoned fugitive: and such coagulated gluten in the state called yeast, is no longer efficacious as a vinous ferment, than during its retention of any carbonic acid gas; and its efficacy is proportionate to the amount of such gas which it has retained or possesses at the time it is used as a vinous ferment.

GRAIN, *one seed of corn or fruit, a general term for every species of corn.*

The maltster, brewer, vinegar manufacturer and distiller, should be well acquainted with the proportionate average value of the extract obtainable and obtained, from every species of grain, both in a malted and unmalted state, as relates to the purpose for which such extracts are made; and should be able to calculate with some degree of precision, the proportionate value of each as relates to the quality and quantity of the product, as compared with any established standard.

The maltster for sale, must be governed in the choice of his grain as relates to specie, by the demand which is likely to be made of him by the purchasing consumer: and in order to be able to appreciate which sort of malt will be most probably required, it is necessary that he should be well acquainted with the average amount of extract produced by each, and its comparative value as relates to quality, and the predilections of prejudice in favor of each; for having to make his purchases at the commencement and during the malting season, and to manufacture a year's supply of malt in six or seven months, he should be in a situation to judge of the comparative quality and price of each sort of malting grain, and be able to determine *a priori*, that which it may be most advantageous for his customers to purchase at the respective current price of each when malted: and although from the present state of theoretical and practical chemical knowledge among brewers and others, it may appear to be of little consequence to the maltster whether or not he possesses any such knowledge, as barley malt is at present only saleable; yet the time may shortly come, when such knowledge being more prevalent among the consumers of malt, their judgment and discrimination may be exercised, and the occasional and frequent use of other grain for the purpose of malting may be resorted to, and the same motive that prompts the use, must induce the supply; while the diffusion of that knowledge which leads to the adoption of other than the accustomed species, should also lead to the attainment of an advantageous system of malting it, and the resulting advantages. And if it is to the maltster's interest to obtain knowledge in the anticipation of its need, so as to be prepared to avail himself of the advantages which its possession may furnish, as soon as the brewer, distiller, or vinegar maker may make a corresponding advance in the attainment; of how much more consequence is it, that the three latter who may be also maltsters for their own use, should immediately endeavour to obtain that knowledge, which will enable them to determine with something like accuracy, which species of grain may prove most profitable to them to purchase for the purpose of malting, or which sort of malt it is their interest to purchase, at the several prices for which it may be offered?

An illustration of the advantage resulting from a possession of such knowledge occurred in the malting season of 1833—1834, when the price of wheat was disproportionately lower than the price of barley, and many brewers were tempted to buy a large quantity of the former without the possession of any knowledge of the proper mode of malting or brewing it;

and while those who possessed the requisite knowledge of both, were enjoying an extra profit of about 10s. to 12s. per quarter above that which they could have realized from barley malt, those who did not possess such knowledge, were getting a much less profit than they would have obtained from barley malt; and we are decidedly of opinion that a difference of not less than 20s. per quarter, was realized by the two parties; a difference constituting an ample reward for the obtainment of knowledge. The following comparative statements of the proportion of the constituent substances of barley and wheat, as ascertained by analysis, must afford a convincing proof to the theoretical and practical chemist, that a difference in the system of malting to produce similar results must be adopted; and that as probably the most skilful and suitable system of malting, will not ensure the production of the same relative proportions in the constituent substances of the malt from each species of grain, so therefore if not accomplished, a difference in the process of brewing and fermentation must necessarily be requisite to produce a beer of similar quality; and thus the greatest dissimilarity both in the process of malting and brewing, is the best calculated to furnish the greatest similarity in the various products.

Barley.			Wheat.		
Gum......	5	parts	Not stated....	4	parts
Sugar	4	,,	Sugar........	0	,,
Gluten	3	,,	Gluten	19	,,
Starch	88	,,	Starch	77	,,
	100			100	

Having obtained valuable experience in the process of malting wheat and brewing of wheat malt in the years 1820 and 1823 both theoretically and practically, I felt quite at home upon the subject in the season of 1833—1834; and have been accustomed to brew wheat malt alone and with barley malt in varied proportions, obtaining about forty-four per cent more extract from wheat malt than barley malt, and the product of one indistinguishable from the produce of the other by any consumer.

In addition to the requisite knowledge of a proper system for the malting of wheat, and the brewing of wheat malt alone or in conjunction with barley malt, every brewer should possess comparative tables exhibiting the average cost of wheat and barley malt, founded upon the addition of the cost of malting and the duty chargeable upon each species of grain, to the original cost of such grain; and from thence to deduce the value of any given standard number of pounds density of the average extract obtainable from each, in order that he may be in possession of that information which will enable him promptly to judge, which grain is the cheapest for him to purchase at the relative market price and quality of each; and for the use of such who choose to purchase my Practical Treatise on Malting and Brewing, I have constructed and therein furnished such tables, as well as the proper system to be pursued in the malting and brewing of wheat malt alone, or in conjunction with barley malt: and it may here be useful to advert to a few of the circumstances, which may render such tables highly serviceable to the intelligent brewer. When the price of wheat appears to be disproportionately lower than the price of barley. When one species of wheat appears to be disproportionately lower than another. When the average growth of wheat may appear to be superior to the average growth of barley. When wheat may upon an average be much better harvested than barley. When wheat may be offered for sale under peculiar circumstances. In such kingdoms or counties, as where owing to peculiarity of climate, soil, or casualties, wheat may be either disproportionately cheaper or of superior quality to barley. For the use of brewers residing in other countries where a malt duty is not levied, and in anticipation of the removal of the malt tax from the British Isles, I have constructed tables without the addition of duty: and as malted wheat is subject to a greater duty than malted barley, in consequence of its greater expansion in bulk in the process of steeping, so will the comparative value of wheat malt to barley malt not subject to duty, be of greater value in proportion than such as is subject to duty.

GRAINS, *the husks, &c. of malt after brewing.*

In the too common mode of brewing, the *et cetera* in admixture with the husks of malt constituting the grains, frequently forms a much more prominent amount than is requisite or desirable, resulting from the choice of improper mashing heats, and an injudicious application in mode and quantity of the mashing liquor, in addition to other erroneous procedure.

From the adoption of an improper system of extraction, not only is the quantity of the extract obtained much less than it ought to be, but the quality of the wort is much inferior; and it frequently occurs that an immoderate length is drawn, and much valuable soluble material is left unextracted, which might be obtained, because the length is found to be sufficient for the required purpose, and the addition of more for the sake of the obtainment, would involve the loss of fuel and time in effecting a diminution of the wort by evaporation, and all the injurious consequences of overboiling; and therefore the waste of extract, which is considered as the least of the two evils is submitted to, which a suitable process of extraction would render quite unnecessary.

The adoption of an improper system of extraction, not only locks up a portion of the soluble materials of malt, and that which is the most valuable; but it involves also the propriety of wasting a considerable portion of the latter extract which is obtainable, lest the proportion of inferior extract should predominate above the superior; and thus the failure in the obtainment of a proper portion of the best, causes the rejection of a portion of the worst; the first error causing a deficit, involving the necessity of committing a second as a remedial result.

Those brewers who experience such unfavorable results, have yet to learn this important fact, that right mashing heats and a suitable quantity of extracting menstruum judiciously applied, will ensure the obtainment of the largest quantity of extract in the least quantity of wort, and a wort of the best quality, leaving scarcely any soluble material in the goods unextracted, and none extracted but what is truly valuable. But such is the inveteracy of prejudice, and the apathy and incredulity of many, that although such an assertion is made and proof offered of its truth and accuracy; yet are they determinedly hostile to enquiry, blind to conviction, immoveable from ancient habits, and sceptical as to all improvements.

That the grains furnished by such brewers are better adapted for the several purposes to which they are usually appropriated is undoubtedly true; and if they choose to furnish them at an individual loss of from 10 to 15 per cent. rather than expend a trivial sum for the obtainment of better information than they possess, it is equally true that such is their own business.

GRAVITY, *weight, tendency to fall to the centre of the earth.*

Gravity is a term used to express or denote that power which causes all substances within the attractive sphere of every planetary body, to fall toward such body in lines converging to its centre.

Affinity and attraction appear to be the compound causes which produce such an effect; and the single term gravity, if used to designate the double cause, may be an unobjectionable term; but if used to imply or convey an impression, that any other than those united causes produce such a result, the term may be calculated to propagate error.

If all bodies are originally composed by the accretion of single atoms to the first united pair, induced by the same power of affinity and attraction as caused the union of the original pair, then the first atom which attracted the second, must be the nucleus of the body and its centre of accretion: and as the power of affinity and attraction possessed by the first, is diminished by its union with the second, and the same power possessed by the second is diminished by its union with the third, so the powers of the two in conjunction must exceed the power of either separately, and therefore must exercise a greater influence in the attraction of a third atom, than the first did upon the second; but it must be remembered that the attractive power of the two atoms upon the third, is not double the power of the first upon the second, inasmuch as a portion of the undiminished power of the two atoms is expended in the exercise of an influence upon each other, and therefore the amount of that power expended upon each other, must be subtracted from the total amount of their power, and the balance left is the amount of power which the two atoms first united exercise upon the third, and by parity of reasoning the three atoms when united, will exercise a diminished power in attracting a fourth, and so on in continuation until diminution can no further go. By this salutary law then, it must appear quite evident, that accretion which is the result of the power of affinity and attraction must have an end, and therefore that the maximum magnitude of all bodies have their assignable limits; and it is upon this principle of diminution that the power of gravity possessed by bodies, diminishes in gradatory proportion to the distance at which they are placed from the centre of the earth, and to the reverse principle may be attributed the increase in gravity of bodies in proportion to their proximity to its centre: and although the attainable maximum magnitude of a variety of bodies, as the result of affinity and attraction materially differ, yet such difference may be attributed to all the variety in composition of such bodies as relates to classes, proportion and arrangement of their ponderable and imponderable atoms.

If the hypothetical view of the subject is correct, that the power of affinity and attraction subsisting between atoms, is undiminished by their union with each other; that the collective power of two atoms exceeds the single power of one, and the collective power of three exceeds the united power of two, and so on *ad infinitum*; it must therefore be evident, that the greater the number of atoms endued with such power, of which a body is composed, the greater must be the collective power of affinity and attraction subsisting between such body, and the earth as a body; and therefore a body placed upon the surface of the earth, or at any distance from it, must press toward the centre of the earth, with a force proportionate to the amount of the collective power of affinity and attraction, possessed by the atoms (thus endued) of which the body is composed.

Suspend a pair of scales in the atmosphere, evenly balanced, and place a body in one scale, without any counterpoising body in the other, and such scale and body will descend or fall to the earth, with a celerity proportionate to the amount of the collective power of affinity and attraction, possessed by all the atoms endued with such powers, of which such body is composed, and the collective power of all the atoms of the earth similarly endued, which are situated within the sphere of mutual affinity and attraction; and in proportion to the exercise of that power, is said to be the gravity of that body; and if a counterpoising weight is put into the other scale which balances such body, and prevents it from falling toward the earth, then is such body said to be of such a weight, as corresponds with the previously ascertained weight or gravity of the counterpoising weight; and hence it will be perceived that the terms gravity and weight are synonymous, and both are indicative of the amount of the force of affinity and attraction, subsisting between the atoms of which the body and earth are respectively composed, and which are situated within the sphere of mutual affinity and attraction.

The terms gravity, or affinity and attraction as the first, equal diffusion or repulsion as the second, and levity or recession as the third, may be used to express the three forces of nature, by which she effects all her compositions and decompositions.

The genera or species of atoms of which all substances or bodies are composed are few; and they are subject to an irrevocable law, and gifted with a defined, yet indestructible power, whereby they are united and disunited, forming solids, fluids and vapours which are subject to transmutation from one state to another.

By the law and power of affinity and attraction those species of atoms which are subject thereto, and therewith endued, unite together whenever they approach within the sphere of mutual attraction, unless opposed by a superior preventive or repulsive force, and form bodies of peculiar properties and characteristics, agreeable to the distinctive properties of the species of atoms of which they are composed, the number, the situation and arrangement of those atoms, and the species, number, and arrangement of the imponderable atoms with which they may be commixed.

Of the possibility of forming such an endless variety of substances and bodies, as appertains to earth and all created worlds, with a very few species of atoms, the innumerable transmutations of forms and figures, varying in magnitude, hue, and shape, as is effected by the few fragments contained in a kaleidiscope furnish a pleasing illustration.

The species of atoms which are subject to the laws and endued with the powers of repulsion and recession, form a component portion of all substances and bodies, and impart to them properties or characteristics of an opposing tendency and appearance, to the properties and characteristics conferred by the species of atoms which are subject to the laws, and endued with the powers of affinity and attraction; and thus all bodies may be said to be compounded of opposing and conflicting elements, and therefore possess the inherent principles of decay, decomposition and ultimate destruction.

By the law and power of repulsion we are to understand, that principle of action by which the atoms of heat enter into the interstices presented by the union of the atoms composing solid bodies, to an amount more than is sufficient to fill them, as induced by the law of equal diffusion, to which the atoms of heat are subject, and the power with which they are endued; and as such law and power is superior to the law and power of affinity and attraction of cohesion, or attraction of aggregation, the atoms which are subject to and endued with the latter power, are separated and repelled from each other, by the impartation or access of heat: and a similar impartation or access of heat to a fluid or vapour, will produce the same effect upon the constituent atoms of such bodies subject to the law, and endued with the power of affinity and attraction; and the term law and power of repulsion must be considered as the effect of the true cause, or more properly termed law and power of equal diffusion, to which heat is subject, and with which it is endued.

By the law and power of equal diffusion, we are to understand that principle of action by which the active atoms of heat contained in one body to a greater amount than in another body, have a tendency to depart from that body possessing the most, and enter into that body which possesses the least, to an amount as may be sufficient to render the quantity possessed by each quite equal; and man availing himself of a knowledge of this law and power, is enabled to convert a solid into a liquid, a liquid into a vapour, and to annihilate the latter as an integral body, by placing such bodies in contact or vicinity with a body which possesses a large amount of imparted heat, or yielding a large amount by its decomposition in combustion.

By the law and power of recession we are to understand that principle of action by which heat recedes from the centre of the earth, and when unopposed or prevented by the superior law and power of equal diffusion, invariably ascends or recedes from it; and causes the ascension or recession of such bodies from the earth, as are compounded of a predominant portion of the atoms of heat, and which may consequently be of less specific gravity than the atmosphere which envelopes the earth.

In consequence of the superiority of the law and power of equal diffusion to which heat is primarily subject, above the law of recession to which it is but secondarily subject, an impartation of heat from the sun to the earth is effected, and every created substance becomes a depositary or magazine for its temporary conservation; and the same law and power which furnishes them with the supply of so valuable a species of atoms, causes them to yield their stores whenever the claims of equality are made to a portion of their contents.

As those species of atoms which are subject to the law of gravity, or affinity and attraction, are said to impart weight to the body of which they are compounded, so the term ponderable applied to such atoms is characteristically distinctive; and the term imponderable, applied to such atoms as are subject to the laws of equal diffusion and recession, is as significantly expressive of their properties as opposed to those which are subject to the law of gravity.

All substances or bodies being compounded of ponderable and imponderable atoms, and therefore of atoms subject to the operation of opposing forces, the tendency of such substances or bodies toward or from the earth, is in the ratio of the amount of the ponderable and imponderable atoms of which they are compounded.

HEAT, *the sensation caused by fire, hot weather, &c.*

Heat pervades all bodies. As a constituent principle in bodies it exists in a latent state; as a non-constituent principle it exists in them in an active state.

The atoms of heat are supposed to be spherical, indestructible, and smaller than the ponderable atoms of which bodies are with them conjunctively composed, and sufficiently small as to be able to pass into, and through the several interstices presented by the union of the ponderable atoms in close contact, without displacing them, provided that not more than is sufficient to fill those interstices enters or passes through, as induced by the law of equal diffusion.

All bodies are compounded of atoms, a portion of which are subject to the law of gravity, such as oxygen, hydrogen, carbon and nitrogen, &c. and a portion which are subject to the laws of equal diffusion and recession, such as heat and light, &c.

The atoms of heat or light possess no innate repulsive power as a cause, but as an effect resulting from their obedience to the law of equal diffusion; and to the superiority of that law above the law of attraction of cohesion or aggregation, causing the impartation of more atoms of heat to a solid body than is sufficient to fill the interstices presented by the cohesive union of their ponderable atoms, and therefore necessarily causing their separation one from another, to a distance proportionate to the amount imparted; and to a fluid or vapour more than a constituent portion of heat, and therefore separating the ponderable atoms which form its constituent portion, yet further from each other than they originally were, and to an extent proportionate to the amount of heat imparted.

The law of recession to which heat is subject is inferior to the law of equal diffusion; and as the term gravity is applied to that law by which bodies are impelled toward the centre of the earth, so with equal propriety may the term levity be applied to that law by which bodies are impelled from the centre of the earth; the ponderable atoms of which the body is composed inducing the former, and the imponderable atoms of which it is composed inducing the latter.

But it is said, and with every appearance of probability, and perhaps certainty, that both heat and light emanate from the sun; and as the impartation to the earth of both from that luminary is to the greatest amount when it is at a meridian altitude, the descent of both toward the centre of the earth, is an apparent contradiction to the hypothetical conclusion, that both are endued with a tendency or power to recede from its centre: but in the support of such an hypothesis is advanced a second, which ascribes to both, the possession of a superior power to recession or levity, and which superior power may be termed equal diffusion, or a tendency to pass from one body possessing a quantity of free and active heat, to another body possessing less, and to an amount sufficient to render the possession of each quite equal: and agreeable to such conclusion it is inferred, that both heat and light are imparted to the earth from the sun, in obedience to this law; and that in obedience to the law of recession, as much as has been imparted in excess beyond an absolute or continued need, again returns to the sun, and thus by the operation of these two laws, a continued circulation of heat from and to the sun, is constantly occurring, subject to all the variations in impartation and abstraction, as is experienced during the various seasons, and induced by a variety of circumstances. In support of this theory we would plead the probable indestructibility of atoms, deduced from a full conviction of the perfections of the deity who created them; and although we may be said to be momentarily convinced and cognizant of the mutability of all things, we deem it but the mutability of substances or bodies and not of the atoms of which they are composed; for while convinced of the infinite wisdom exemplified in the formation of innumerable substances in endless variety, from a very few species or classes of atoms, we still trace a more abundant cause for admiration, when we view and reflect upon the mutations to which they are subject; and being reminded of the declaration of the omnipotent author of all created things, that they are mutable, that they change and pass away, and time shall be, when they shall be no more, and being daily convinced of the faithfulness of his promises, by the observance of their incessant fulfilment; we cannot but connect the consequent expectation of the completion of their fulfilment with the indestructibility of atoms, as a necessary condition to their fulfilment. And from the conviction of the perfections of their author, we deduce, that the creation of a sufficient number of atoms and no more, for all the purposes of time and eternity, was but the result of his omniscience and consequent comprehension of their need, and any deficiency or superfluity would imply an imperfect perception of future need; and the future creation of atoms to supply the future need, would imply present inability to provide for such future need; and therefore anything short or beyond repletion, would afford an idea of imperfection, which the results of no possible investigation can justify. If then the doctrine of the indestructibility of atoms is correct, and the supply of heat to the earth is from the sun, and that continually; how are we to account for the undiminished impartive power of that luminary without replenishment? And if replenishment is equal to its loss, where is the inexhaustible source, and what the method of supply? And if the earth is ever receiving and never losing, where is the capacious and unfathomable abyss to store the accumulated stock of ages? And if atoms are destructible, where are the measureless and boundless realms of empty space, to receive the proceeds of their decomposition?

A body being in a constituent or natural state, and in close contact or sufficient proximity to another body, which possesses a greater quantity of atoms of free or active heat than itself, will receive as much free or active heat from that body as will render the possession of each equal, the transmission being induced by the law of equal diffusion, to which free or active heat is subject: and if the transmission from the body possessing the major quantity to the body possessing the minor, overpowers the attraction of cohesion that united the atoms subject to the law of gravity, of which such body is partly composed, and causes their separation, the effect produced is termed expansion; and if any subsequent abstraction of heat from that body enables those atoms of which it is composed, which are subject to the law of gravity, to approach closer together, or to unite, as induced by attraction of aggregation and cohesion, the effect produced is called contraction.

To abstract the free or active heat possessed by a body, it is sufficient to place in contact or proximity with it, another body possessing less heat than itself; and by the law of equal diffusion to which heat is subject, the transmission from the major to the minor possessing body will ensue; but to abstract a part or the whole of the latent heat of a body, it is necessary to place such body in close contact or proximity with another body which possesses not only as much less heat as is equal to the abstraction of the whole of the free or active heat of such body, but a part also or the whole of its latent heat, the latent heat in such a case becoming active, in obedience to the law of equal diffusion.

Latent and active heat are arbitrary terms, used to denominate heat in a twofold state;—latent heat when it exists in bodies in a quiescent state, and active when in a state of motion or liable thereto. But strictly speaking heat cannot be permanently latent, being ever liable to detection, liberation, freedom and activity, as the result of abstraction, induced by the law of equal diffusion, or the decomposition of the containing body by a variety of methods; and therefore it is necessary not only to conclude, that there are not two species of heat, termed latent and active, but that the single species is occasionally latent or active as induced by circumstances.

All bodies are compounded of atoms in a state of close contact, a portion of which have a tendency to unite together, as induced by the laws of affinity and attraction; and a tendency to fall toward the centre of the earth, as induced by the same laws, but which tendency is termed gravity; and another portion which have a tendency to separation, as induced by the law of equal diffusion; and a tendency to ascension, as induced by the law of recession.

Those atoms which are subject to the laws of affinity and attraction, alias gravity, may appropriately be termed ponderable; and those which are subject to the laws of equal diffusion and recession, may be termed imponderable.

The atoms of heat and light are therefore imponderable, and their impartation to any body will not increase its statical weight.

The impartation of heat to a body will not decrease its weight, provided a sufficient quantity of heat is not imparted to that body, as will cause one single ponderable atom to be separated from the rest, beyond the limits of aggregate attraction; but as soon as such is produced then is there an actual diminution in the weight of that body, and in amount equal to the number of ponderable atoms which are placed beyond the sphere of such attraction.

When the impartation of heat to a body is sufficient to separate the ponderable atoms one from another, and thereby such body is increased in magnitude; then is its specific gravity decreased, but not its actual weight.

The decrease in the specific gravity of a body, implies that an equal bulk of that body in an expanded state by heat, will not weigh so much as an equal weight of that body previous to its expansion.

The atoms of heat being subject to the primary law of equal diffusion, and the secondary law of recession; the transition of heat from a body as induced by the law of equal diffusion, is in the direction of the abstracting body; but if induced by the law of recession, unopposed by the law of equal diffusion, its transition is in the line of perpendicular ascension.

When the operation of the primary law is unopposed by the secondary law, heat will invariably and uninterruptedly ascend from the body from which it emanates; and whenever the primary law is in operation, it is always strongly opposed by the secondary.

Place a body possessing the most active heat, above a body possessing the least, and there will be a transmission of a portion of heat from the upper to the lower; but reverse the position of the two bodies, and the transmission of the greater to the lesser possessing body will be much more abundant.

From these facts may be inferred, the mechanical advantages to be derived, as relates to the economical and prompt transmission of heat, in placing the recipient over the imparting body, arranging for its perpendicular transmission, and extending as far as is mechanically convenient, the receiving surface.

Some bodies possess more latent heat than other bodies, as a necessary constituent of the compound in its natural state; and such latent heat is not subject to the law of equal diffusion until such body has parted with all its free or active heat, or until such body is subjected to partial or total decomposition.

In the case of the partial decomposition of a body, as much latent heat is rendered active, as is contained in the interstices furnished by the union of the spherical ponderable atoms of which the body is composed; and which being separated from the body and impelled beyond the sphere of attraction of aggregation, the removal of every such atom liberates the imprisoned constituent heat appertaining to such atom.

By the impartation of heat solid bodies are converted into fluids and vapours; and by the abstraction of heat, vapours and fluids are converted into solids.

A solid consists of ponderable atoms united together in close contact by attraction of cohesion, and the interstices presented as the result of such union, partially or totally filled with imponderable atoms.

A fluid consists of ponderable atoms, not in a state of cohesive contact, commixed with imponderable atoms, in greater quantity than is required to fill up the interstices presented by a solid; yet are they held together by attraction of aggregation, and in this state of semi-freedom are subject to diffusive motion within the sphere of such attraction.

A vapour consists of ponderable atoms blended with a much greater quantity of imponderable atoms than is the case with a fluid; consequently its ponderable atoms are separated to a greater extent than are those of a fluid; and as in the case of a fluid, the whole of its constituent atoms are confined within the limits of the sphere of attraction of aggregation and are susceptible of diffusive motion within that sphere.

By the impartation of the imponderable atoms of heat to a solid, the first effect is to completely fill the interstices presented by the union of the ponderable atoms of which the solid is composed: continue the impartation and the attraction of cohesion which kept the ponderable atoms in close contact is overpowered, and they are separated one from the other, and the solid is thereby converted into a fluid: continue yet further the impartation and the fluid is converted into a vapour, by a separation of the ponderable atoms yet farther from each other: proceed yet further with the impartation, and you separate the ponderable atoms beyond the precincts of the sphere of aggregate attraction, and its annihilation as an integral body is effected.

Reverse the operation and cause ponderable atoms having an affinity for each other, to come within the sphere of mutual attraction, intermixed with the imponderable atoms of heat to a considerable amount, and you constitute a vapour: next abstract a sufficient quantity of heat, as will enable the ponderable atoms in obedience to the law of attraction, to approximate close to each other but not cohere, and you then constitute a fluid; continue the abstraction of heat until the ponderable atoms cohere, and then you constitute a solid.

These analytical and synthetical operations may be illustratively performed on ice as the basis of the first process; and by an admixture of the right proportions of oxygen and hydrogen gases as the preliminary of the second.

Both vapours, fluids and solids are conductors of heat in variable proportion; and as a general rule solids are better conductors than fluids, and fluids than vapours.

The conductive power of heat of solids, fluids and vapours, is in the ratio of the proximity of their ponderable atoms to each other, and to their constituent amount of latent heat.

Bodies which are incombustible at a moderate temperature, receive and part with caloric without experiencing a partial or total change; but combustible bodies are partially or totally decomposed in proportion to the quantity of heat received.

The impartation of heat alone causing the decomposition of a body, may be said to effect it mechanically; but the impartation of heat as an agent, to aid and facilitate the fulfilment of the laws of affinity and attraction subsisting between the atoms of which the combustible body is composed, and a body in contact or proximity, may be said to effect the decomposition chemically.

Latent heat becomes active in every case of the condensation of solids, fluids, or vapours; and whether the condensation is effected by mechanical pressure, causing the ponderable atoms of which the body is composed to approach nearer to each other; or by chemical attraction causing the ponderable to approach nearer to each other, as frequently occurs in the blending of two or more bodies together, the liberation of latent heat and its evolation from the body is a resulting consequence.

Heat imparts neither flavor or color to any body as a principal, but is the frequent cause of the impartation as an agent.

The mode in which heat acts as an agent in producing flavor or color, or altering or changing the properties of bodies, is by its overpowering the attraction of cohesion and aggregation, which govern the ponderable atoms of which such bodies are composed, and thereby aiding and facilitating the operation and fulfilment of the laws of affinity and attraction, subsisting between any of the ponderable atoms composing such bodies and other bodies in contact or vicinity; and causing the impartation of atoms to, the abstraction from, and re-arrangement of the constituent atoms of those bodies.

Heat is the principal agent by which the decomposition and recomposition of bodies is effected; and a variety of changes are attributable to it both as a principal and an agent.

In the partial or total decomposition of bodies, whether by deflagration, solution, evaporation, or fermentation, latent heat is invariably rendered free, and evolved in proportion to the amount possessed by the body, and the extent of its decomposition.

HERMETICAL, *chemical, sealed or closed up,*

In the various operations of chemistry, it is frequently a necessary and important measure, to prevent the access of air to many substances, and to prevent the loss of others by evaporation or decomposition; and to enclose them in an impervious vessel, hermetically sealing the mouth or way of access to its interior, is the method frequently adopted.

For the preservation of such substances, glass vessels are generally best adapted; and when an occasional access to the contents, and hermetical security in the interim is needful, a glass stopper accurately ground and fitted into the mouth of the vessel is requisite; but when permanent security without access is required, it is usual to hermetically seal the aperture, which may be effected in a variety of ways.

In the construction of thermometers, it is absolutely necessary, that the space within the glass tube, which is allowed for the expansion of the mercury, should be a vacuum; for as its purport is to denote the amount of heat contained in the substance in which it is immersed, and the indication is effected by the extent of the expansion of the mercury in the tube, it is therefore necessary that no opposing force should exist therein.

The proper quantity of mercury being put into the tube, the residue of its content is necessarily filled with air, and if such air was hermetically enclosed with the mercury, being elastic, it would admit of the expansion of the mercury to a certain extent, under conditional circumstances; yet such expansion would only be effected by the condensation of the air, and as the opposing force of the air to the expansion of the mercury, would increase in proportion to the extent of the condensation; and as air is also subject to expansion from the impartation of heat, the air would present an elastic or expansive force to the inelastic and expansive force of the mercury, as the air within the tube might be subject to the impartation of heat by the surrounding medium, or the reception of its heat by that medium, which might be forced out by the mechanical pressure of the mercury; and hence it is evident that the two fluids hermetically sealed in the same tube would not furnish an accurate indication of the amount of heat contained in the substance in which the thermometer was immersed. And in case the tube containing the mercury and air was not hermetically sealed, and the upper end left unclosed, in order that the mercury when expanding might drive out the air from the tube; yet would the pressure of the column of air, in the ratio of its varying weight, militate most seriously against the accuracy of its indications, and very much diminish the value of the instrument as relates to position in the various uses to which applied. For a description of the mode of effecting such vacuum, and hermetically closing the tube, see article "thermometer."

The access of air to hops very rapidly deteriorates their quality and diminishes their weight, and to seal them hermetically provided they are in a right condition, is to ensure their lengthened and advantageous preservation. The process may be performed at a very trifling cost, and experience has fully and most satisfactorily demonstrated its efficacy.

Liquids or other substances enclosed in casks, and its apertures closed with cork or harder wood are by no means hermetically sealed, as wood is pervious to air, the gaseous products of fermentation permeate its pores, and liquids are slowly and gradually diminished by transudation therefrom. Even glass vessels well closed with sound corks, are not hermetically sealed, unless the external surface of the cork and orifice is well luted and coated with a good cement.

HOMOGENEOUS, *having the same nature or principles.*

Strictly speaking, the composition of no body is homogeneous, either as relates to substance or ultimate principles, or atoms; for by analysis it is proved, that all bodies are divisible into substances or atoms of different species or proportion, or arrangement of species; and even such gases as are termed simple, such as oxygen, hydrogen gas, &c. are compounds of ponderable and imponderable atoms.

But the term homogeneous may be a convenient one, when used to denote an apparently simple body, from an acknowledged and well known compound: thus wort may be termed an homogeneous fluid, and beer a compound, the latter furnishing spirit by the analysis of distillation, which the former will not, its capability to furnish it having been effected by vinous fermentation; but the former is as susceptible of division and subdivision as the latter, and the homogeny of the one is not more demonstrable than that of the other; and at best, the term appears to have been coined for the use of an earlier age, when the analysis of many substances might have been deemed impracticable, and therefore supposed to be indivisible.

HOPS, *the flowers and seeds of a plant termed the hop plant.*

The flowers and seeds of the hop plant (technically termed hops) are moderately used for medicinal purposes, but most extensively in the brewing of beer, as a preventive to acetous fermentation, and as impartive of a grateful flavor.

Hops by the process of decoction, will yield both an aromatic and a nauseous flavor, and it is the brewer's province to determine the line of demarcation between the obtainment of the whole of the former, without any of the latter.

The quantity of aromatic oil and terree bitter extract furnished by hops of various species, and grown on different soils and in different counties, differs widely; and in selection the brewer should be governed by the purpose for which he intends to appropriate their use.

In brewing, the brewer is or should be influenced by a double motive, both in the selection of his hops and the obtainment of their extract,—a regard to the requisite flavor, and a due attention to the amount of the preservative principle which they afford.

The preservative principle of hops consists in the carbon which they furnish to the wort, which uniting with the oxygen imparted to the wort from the atmosphere, furnishes carbonic acid; and unless oxygen is imparted with greater rapidity than is consistent with the formation of carbonic acid, and its evolation from the wort in the form of gas, and in proportionate unison with the formation of spirit, an acetous fermentation cannot occur; hence it is evident, that an ample supply of carbon to wort, by the medium of hop extract, furnishes the best safeguard against the exigencies of a rapid and abundant impartation of oxygen in a short or long period of time.

As wort is liable to an impartation of oxygen from the atmosphere with rapidity and abundance, both in the mash tun and in the under back, particularly in hot (and what is termed) thundery weather; an early infusion of hops, may be desirable as a remedy, to furnish carbon to unite with the oxygen imparted; but as "prevention is better than cure," the adoption of a proper system of extraction, preventing the need of a remedy, is far better than relying on its efficacy.

Wort being also liable to the absorption of a superfluous quantity of oxygen from the atmosphere, by a too extensive and protracted exposure in the cooling backs in sultry weather, an extra quantity of hops in boiling may be desirable as a suitable remedy for such a contingency, or as an alleviation to the resulting evil; but the same observation again forcibly obtrudes, "prevention is better than cure," and therefore their prompt transition from the hop or cooling back to the fermenting tun, by the aid of a refrigerator, is a much safer and more economical method to avoid an evil of serious magnitude.

As in the spring and summer, and more particularly in sultry weather, the atmosphere is highly charged wlth oxygen; and as the combination of the oxygen of the air, with the carbon of the wort, is the principal or first cause of fermentation, so the presence of a greater amount, is the inducing cause of a more rapid and extensive fermentation than occurs in the autumn and winter, or temperate weather; hence the use of more hops, and hops of the best quality are needed, to supply a suitable quantity of carbon to meet the demands of combination with the extra oxygen imparted. But although such a remedy is necessary, in conjunction with measures of prevention to the impartation of too much oxygen, the less of the remedial and the more of the preventive measures that are adopted in the operations of preparation for and in the process of fermentation, the more advantageous and successful will be the result.

The supply of carbon to wort by the medium of hops, whether as relates to their quality or quantity, should be proportionate to the quantity of oxygen that such wort is liable to derive, whether naturally and unavoidably, or in the absence of suitable precautions to prevent its impartation to excess, or whether resulting from neglect, carelessness, or the want of the knowledge of a proper system of brewing and fermentation:. and on either hand the supply should be proportionate to the time, circumstances, and purposes under and for which it is to be kept previous to consumption.

The finest flavor of hops resides in an essential oil, which is very volatile, and is soon lost by exposure to the atmosphere; and therefore much care should be taken to prevent all unnecessary loss of it by an adoption of the best means to prevent its access, or as little of it as is possible, from the time they are gathered and dried until the time of consumption; and as so desirable an object may be accomplished at an expense of from one shilling to eighteen pence per pocket, no holder of a large or even a small stock, should be without a knowledge of the most suitable method, nor fail to adopt it in practice.

A great portion of the fragrant oil may be lost in the drying of hops on the kiln; and this indispensably necessary process should be conducted so as to effect an evaporation of the juices, which would cause a putrefactive fermentation if not got rid of, with as small a loss of the essential oil as is possible.

Much of the essential oil of hops is frequently injudiciously lost from the copper, and is not properly blended with the wort, by the pursuance of an erroneous system.

An erroneous prejudice founded on the prejudicial results of an improper practice in the use of new hops, exists in the minds of many brewers; and they prefer that the atmosphere should first deprive them of their best qualities to suit their erroneous practice, rather than obtain the needful information, so as that they might adapt their practice to the condition of the hops, and thereby reap all the consequent benefits. And such brewers generally use a portion of yearling hops, whose best qualities have been deteriorated by the atmosphere, in order to avoid the obtainment (as they term it) of too rank a bitter from the entire use of new.

The action of the atmosphere upon hops is chemical and not mechanical. The deterioration in quality and weight resulting from the access of air to hops, arises from the combination of the oxygen of the air with the carbon of the hops, induced by affinity and attraction; and the resulting consequence is the formation of carbonic acid gas, and its evolation from the hops, causing an abstraction of their preservative principle, diminishing their weight, and injuring their color as a marketable stock.

In the month of May, 1838, while writing this article, I am using Sussex hops of the growth of 1835 of medium quality when purchased, costing upon an average about 75s. per cwt. which were hermetically sealed in about two months from the time of picking; which are now superior to any yearling hops of the same growth and original quality, are deteriorated but a very little in quality, are diminished but little in weight, and now weigh more than the excise weight; are also perfectly free from crust, the color not greatly altered, and appear as if they would keep yet ten years longer.

HYDRAULICS, ***the science of raising and conveying water.***

An application of science to the mechanical arts, and its introduction into the multifarious avocations of every class, has imparted to civilization and social and domestic happiness, a rapid and unparalleled progress in the last half century.

Among the diversified objects which have claimed and obtained its attention, the facility of raising and conveying water stands conspicuous.

To raise water from the bowels of the earth by a pail or other vessel suspended to a rope, attached to a windlass, is an ancient and purely mechanical operation; but not only to raise it by the aid of a pump to the surface of the earth, but to impel it to very considerable altitudes above it, and to a very great distance, is truly the application of scientific principles to mechanical art.

A conception of the idea, that the weight of the atmosphere pressing upon the surface was sufficient to force it up a pipe, provided a vacuum was created therein; and the demonstration, that the weight of the atmosphere, is such as is equal to balance a column of water about 32 feet in height, or in other words to force the water to rise in the pipe about 32 feet in height, was scientific: but a conception of the necessary apparatus to carry such a principle into effect, was mechanical.

Should it be objected to this definition, that the mechanical art is one of the numerous branches of science, the explanation offered is, that the mind of man is the soil from which the seed of science springs, that natural philosophy is the plant it rears, and all the arts are branches from the parent stem, and that in designating the emanations of the mind, which reveal and satisfactorily confirm any of the principles of natural philosophy with the term scientific, it is used ***par excellence*** in contradistinction to the inferior products of the mind.

The syphon is an instrument used for the raising of liquids above their own level, and delivering them at a point below, the operation being to create a vacuum in the bent pipe, by withdrawing the air therefrom, by the aid of the lungs or by other means, when the atmosphere pressing upon the surface of the liquid in the vessel, in which the shortest leg of the syphon is immersed, forces it up the pipe, over the circular bend, and it is finally delivered from the longest leg of the syphon. If the two legs of the syphon were of equal length, it might be filled by the creation of a vacuum therein, but the liquid would not continue to flow therefrom, because the pressure of a column of air on the orifice of the leg of the syphon without the vessel, would be equal to the pressure on the orifice within, and the two columns of water being equal, and equally supported by equal columns of air, it would remain stationary within the pipe; but increase the length of the external leg, and the external or descending column will exceed in length and weight the internal or ascending column, while the pressure of the atmosphere upon each column will remain the same, and the difference in the weight of each column of water, will therefore be the motive power to a continuous flow of the liquid.

The discovery resulting from observation, experiment, or practice, that fluids will flow from one elevation to another of equal altitude, let the intermediate descent or distance be ever so great, by the aid of pipes, or natural conducting channels in the earth through strata of an unabsorbent nature, is now continually turned to a beneficial account for the obtainment of water from an elevated spring, at a very considerable distance from its source; and it is from a knowledge of this fact, that experimental borings are frequently made in the bottom of wells, or from the surface of the earth in the vicinity of elevated ground, from an expectation of the liability of penetrating into a subterraneous channel, and the obtainment of a supply of water therefrom in its passage from such elevated source. By this means the obtainment of an abundant supply to wells is frequently effected, and jetting fountains of water are caused to flow above the surface of the perforated earth. In reflecting upon the numerous blessings connected with an abundant supply of water, we contemplate it rising through the earth and overflowing its surface, irrigating the plains, sustaining and supporting vegetation beneath a scorching sun, slaking the parched tongue of thirsty man and all the animated countless tribes; furnishing the fountain for ablution, the flowing streamlet for mechanic power, the deep broad river for the burdened ship, the innumerable sources of circulating supply to seas that constantly are diminishing from the abstraction of the fleecy vapours that climb the ambient atmosphere, and form the lofty floating clouds; those intervening shades that intercept the burning ray, those extensive reservoirs of rain, of hail, of mist, and snow, which fly before the wind, and bursting yield their treasure to the mountain top, the lowlier hill, and all the arid plain. In this hydraulic endless chain we view the mountains and the hills as necessary links; their composition, caverned and fissured rocks, covered with chalk and mould and verdant grass: their altitude, sufficient to arrest and burst the deep fraught vapour laden clouds: their texture, loose in the upper surface and pervious to the falling mist and rain, or to the melting snow or hail; but their base a capacious vase of adamant, filled with the filtered fluid, ever full and ever overflowing, yielding a host of pure translucent streamlets trickling down its sloping sides, tracing their devious way through every crack and crevice, until they make their final exit in some bubbling spring, and run the unwearying circulating round again.

HYDROSTATICS, *the science of weighing bodies in fluids.*

In the various departments of the arts and sciences, a knowledge of the relative weight of one body or substance to another, is both exceedingly useful and highly important; and as the adoption of a fixed standard by universal assent was found necessary, by which to compare the relative weight of various substances, in order to ensure accuracy in calculation, and a correct intersocial communication of experimental results, &c.; and as distilled water has been ascertained to be the most suitable substance for the purpose, the choice of it has been generally made.

To ascertain the relative weight of any body or substance, to a quantity of distilled water of precisely the same magnitude or bulk, if an attempt was made to ascertain by admeasurement the exact size of that body, and then to apportion the exact quantity of water by admeasurement to equal the bulk of that body, and then to weigh one against the other, and note the difference in weight, and afterwards determine the relative weight of the body or substance to the water, would be a task, but in few cases practical to perform, and under the most favorable circumstances, would be difficult and tedious to accomplish with accuracy.

But an easy and simple mode of determining the enquiry presents itself to the mind, on the consideration, that as a body or substance totally immersed in water, must displace exactly as much water as is equal to the bulk of that body, so the weight of the water displaced, set against the weight of the body or substance immersed, will exhibit the relative weight of the one to the other.

To illustrate this theorem, let us suppose that a cubic inch of iron or any other substance is first weighed in air, is then immersed in distilled water, the vessel containing it being exactly full: and the water which is consequently displaced is accurately weighed in air, and the relative weight of each to each will thereby be discovered, and the weight of iron or other substance in air, will be found to be much greater than the water which is displaced.

The mode of discovering the relative weight of various fluids to distilled water, is effected by a variety of instruments, such as the ærometer, hydrometer, saccharometer, &c.

HYPOTHESIS, *a system formed upon supposition.*

The avenues to the mind are the five senses, seeing, hearing, tasting, smelling and feeling; and all the principles of knowledge are conveyed thereto, by their medium, and moulded into convincing facts and indubitable truths, by the powers of reason and reflection.

By such faculties the mind is informed of the magnitude, form, properties, and condition of innumerable bodies; but their powers of communication are limited, and such is the insatiable thirst of the human mind for knowledge, that when material substances are presented to either or all the senses, of which they are incompetent to furnish the mind, with satisfactory and conclusive details relative to such substance, then is the aid of reason and reflection called in, to devise and direct the process of analysis, synthesis, and a variety of other methods, to unravel and unfold the several mysteries, which the unassisted senses cannot otherwise comprehend and accurately convey; and having collected and arranged all the available evidence, the judgment pronounces a determinate or doubtful decision thereon.

But nature has secrets, which hitherto no mental powers of the keenest penetration, lucid discernment, and energetic research have yet been able to discover and develop: yet such is the human mind, that no impediment, no barrier, nor inscrutable and impenetrable obstacle in the way to the attainment of illimitable knowledge, is sufficient to deter its daring progress; and if it cannot untie, it cuts the gordian knot with an hypothesis.

Substances may be decomposed, and separated into their several species of atoms, but who can see, hear, taste, smell, or feel them; yet are they divided, collected, and arranged into classes, and their presence made manifest by some unerring test, which proves a succedaneum to the senses.

But who can tell the form, the size and properties of atoms, the laws that unite and disunite them, and whether or not they are imperishable? To endeavour to furnish a satisfactory affirmative reply, would be a hopeless task, and therefore conjecture must occupy the place of proof, and hypothesis the place of demonstration.

If then the animal faculties of man are not competent to penetrate into the arcanum of nature, and view the formation of atoms; to contemplate their form and ascertain their magnitude; to note their species and learn their properties; to study the laws under which they congregate, and mark the affinities which prompt their union; to see the nucleus atom exerting its attractive powers to draw some roving fugitive to itself, that may chance to come within its sphere of influence, and hold it fast by strong cohesion; and then behold the pair attract a third, the three a fourth, and so on in succession, until atom unto atom joined, create a mass destined for some useful purpose; why therefore should the mind, untutored by the senses, strive to furnish fiction as a substitute for truth? The reply is obvious. Nature is the teacher and man the pupil. Her works are synthetical, and man's analytical. Her's are the results of knowledge and boundless power, man's the crude efforts of weak and defective faculties. She composes with skill and wisdom, knowing well her resources and capabilities, he decomposes with cautious, slow and erring steps her wondrous substances, to learn their composition and the laws of their formation, desirous to do the same by imitation. She proceeds unimpeded to the end, he stops short at her beginning—the knowledge of first principles; and having toiled till hope no longer aids, he finishes his labours with an hypothesis. And why an hypothesis? Why not quit the task, which cannot be performed, rather than add fiction to fact, and by blending truth with supposition, cause doubt to mar the beauties of the whole? Because man aims at workmanship synthetical; he tries his hand at composition; his materials are imperceptible and untangible, and he cannot dispense the laws that govern them, and therefore in the absence of a rudimental knowledge of the operations which he has to perform, and of the elements with which he has to compound, he frames an hypothesis relative to first principles, founded on the opinion of others, his own observations, and analagous evidence; and judging *a priori* the effects that may be expected to result from the operation of certain causes, it becomes his task to adopt the necessary measures for the fulfilment of his purpose; and on the correspondence between his hypothetical views and rudimental truths, or their approximation thereto, depends the measure of success attendant on his labours.

The formation then of an hypothesis is frequently highly useful in facilitating the discovery of truth, because the synthetical operations which are induced by its construction, serve either to elucidate truth or dispel error.

The meaning of the term hypothesis being, a system formed upon supposition, the moment that such system is proved to be correct and true, it ceases to be hypothetical to that mind which has made the discovery, or to such other that has received a convincing proof thereof; but to those minds to which its demonstration has never been submitted, or convincing proof afforded, the system is still hypothetical, and all the advantageous results arising from the endeavour to inform and convince those minds, or that may flow from a prescribed practice, resulting from an hypothetical system may serve to indicate the utility of the original hypothesis.

An hypothesis relative to first principles is then the only standard which man can form, to which as a touch stone he can resort, to test the several theories which he may himself create, or which may be the mental production of others; and whereby he may be able to judge of their value as directors to experimental essays, and the beacons to practical knowledge and profitable truths.

To furnish an elementary work for the use of maltsters, brewers, distillers, vinegar makers and others, who have in their various avocations, to manipulate with perceptible and tangible substances, compounded of imperceptible and intangible atoms; and the nature and purport of whose operations are the impartation, abstraction, and transmutation of atoms, for the partial decomposition and recomposition of solids and fluids, and for the conversion of solids into fluids and fluids into vapours and gases, and the reconversion of vapours and gases into fluids, and fluids into solids; it is truly desirable that such work should convey correct and accurate information relative to the species and properties of atoms, the number of their classes, the various laws to which they are subject, the powers with which they are endued, and much beside; but where is the human being that ever did or does possess, that intuitive or derived knowledge sufficient to furnish such intelligence, as would prove convincing, conclusive, and satisfactory? In the absence therefore of knowledge so valuable, so interesting and useful, I have presumed to substitute hypothetical information relative to first principles, instead of indubitable facts and truths in this elementary work; and the reader being apprized thereof, it will be his business to receive much which for the convenience of illustration, may have been stated as facts and fundamental truths with care and caution, knowing them to be but hypothetical; and however plausible, probable, and apparently well framed may be the system, yet still it is but hypothetical.

IGNITE, *to kindle, fire, set on fire.*

There are a very extensive variety of substances, a commencement of the decomposition of which, is effected by ignition.

By the term ignite, we understand the act of applying a substance in a state of combustion, in proximate or close contact, with another substance which is liable to decomposition by combustion; and by the term combustion we understand that peculiar mode of decomposition, by which substances in such condition furnish the products of vapour, gases, heat and light

In this act of producing or causing the decomposition of a substance, by the products of a substance in a previous state of decomposition, we recognize that universal and widely established law—the innate power of destroying as well as producing its own kind, with which all substances are invested.

To cause a commencement of the decomposition of a substance by ignition, it appears necessary, that the light, heat, and oxygen emanating from another substance in a state of incandescent decomposition, should be brought within the sphere of attraction of those atoms, of which the substance in a state of decomposition is composed; and that a transition of the atoms of heat and light, and oxygen from the body in a state of combustion should occur; and that a combination of the transferred atoms with the resident atoms of the latter body should take place. In all incandescent bodies carbon forms a large portion of the class of atoms of which they are compounded. The oxygen which is transferred from the body in a state of combustion, with its carbon as a component of carbonic acid gas unites with the carbon of the body not in a state of combustion, and the formation of carbonic acid is the result. But the transferred oxygen is accompanied by atoms of heat, which uniting with the carbonic acid, converts it into gas, and thus far an accretion has occurred to the body not in a state of decomposition by the transference to it of a portion of two or more species or classes of atoms. But by this transference the affinity which subsisted between the carbon of the body not in a state of combustion, and the other class of atoms of which it is composed, is overpowered by the superior affinity subsisting between the transferred atoms of oxygen and the resident carbon; and what is the result?—the formation of a new compound called carbonic acid, which would remain resident and fixed in the body not in a state of combustion, did not the atoms of heat accompany the atoms of oxygen, and thereby create a triple instead of a double compound. And what is the difference in the properties of carbonic acid and carbonic acid gas? The difference consists in the greater specific gravity of the former to the latter, for as the atoms of carbon and oxygen are ponderable, and the atoms of heat imponderable, and as the space occupied by three classes in the compound called carbonic acid gas, is greater than the two classes in the compound called carbonic acid; and the weight of the three classes is no greater than the weight of the two; so is the relative weight of each to atmospheric air, compared with the amount of its displacement by each; or in other words, as a definite weight of carbonic acid gas, will displace a greater quantity of atmospheric air than the same weight of carbonic acid, so the relative weight of the two unequal quantities of air displaced, will denote the specific gravity of the displacing substances, as compared with the air displaced.

Thus it appears evident, that previous to the decomposition of a substance by combustion, accretion precedes abstraction, and that such accretion is absolutely necessary; for as the atoms which compose the combustible body are united by attraction of aggregation or cohesion, so will they remain united until severed by a superior force; and it is by ignition that the superior force is furnished, sufficient to cause the commencement of combustion; for as the gaseous products which emanate from the body in a state of combustion, are placed in vicinity or close contact with the resident atoms of the body which is not in a state of combustion; so by the power of affinity subsisting between the fugitive and resident atoms, and a mutual attraction, they form a new compound of carbonic acid; and such compound being rendered gaseous by the addition of heat, a commencement of the combustion of the other body is effected; and thus the products of the decomposition of one body will cause the commencement of the process of decomposition of another body, provided there subsists an affinity between the fugitive atoms of the one, and the resident atoms of the other, and they are placed within the sphere of mutual attraction.

IMMOBILITY, *unmoveableness, resistance to motion, inert.*

All material substances are compounded of solid and imperishable ponderable and imponderable atoms, divisible into distinct classes, and are immoveable as relates to innate powers; but are all subject to motion as relates to endowed powers; the ponderable atoms being endued with the power of affinity or desire to unite with each other, and the power of attraction or capability of accomplishing that desire, and also being endued with the power of gravity or desire to fall toward the centre of the earth; and the imponderable atoms being endued with the power of equal diffusion or desire to move from one body possessing the most to another body possessing the least number of imponderable atoms, to an amount sufficient to render the possession of each body equal, and endued also with the power of recession from the centre of the earth, or desire to return to the sun, the source from which it emanates.

Thus all the atoms of which bodies are composed are innately inert, but all are endued with motive power; yet is that motive power of a diversified and opposing character, and from its conflicting operations results all the harmonious productions, decompositions, transmutations, and reproductions which are incessantly occurring throughout the universe.

Affinity as relates to atoms, may be termed a principle of desire with which they are endued, and under the influence of which they are impelled to unite with each other; which desire is regulated and controlled by unerring rules and invariable order.

Attraction as relates to atoms, may be termed the force or power which is exerted between the atoms under the influence of such desire, by which their union is effected; which power is limited as to force and extent.

Attraction of cohesion as applied to atoms, is that force or power by which atoms possessing a desire to unite with each other, and which having been placed within the limits or sphere of mutual attraction, have been united, and remain united under the influence of innate inertia, until severed by some motive force superior in power to the force of attraction of cohesion and inertia.

The law of equal diffusion or repulsion as relates to atoms, is that force or power, by which one or more classes or species of atoms are impelled to a transference from one body possessing a larger quantity of such class or classes, to another body posessing a lesser quantity; the transition continuing until both bodies possess an equal quantity.

The form of atoms being spherical, they can only touch each other at minute points when united by attraction of cohesion, and a substance thus composed, must present interstices between the points of contact.

Atoms of heat and light being smaller than the ponderable atoms of which bodies are composed; and sufficiently small to occupy those interstices in numbers, without separating the ponderable atoms from each other; all solid bodies however dense in texture, possess enclosed in such interstices, large quantities of the atoms of heat and light.

All bodies, whether solid, fluid or gaseous, possess what may be termed a natural quantity of heat, incidental to its integral state, but which quantity is not fixed and arbitrary, but varying within an extensive range.

The atoms of heat are subject to what may be termed the law of equality, or that tendency with which they are endued to leave that body in which they are most abundant, and pass into some contiguous body in which they are less abundant. By this tendency to transition, the interstices resulting from the cohesion of the ponderable atoms of which a solid is composed, possessing the least quantity of heat, are first filled, and if the transition of more atoms of heat to such body than is sufficient to fill the interstices occurs, then will the ponderable atoms composing such body be separated one from the other, and to a distance proportionate to the number of atoms transferred.

Repulsion is an effect resulting from this transition of heat to the body, the ponderable atoms of which it is composed being separated one from the other, by the forcible entrance of the atoms of heat into the interstices, to a greater amount than is sufficient to fill them, induced by their endued power to maintain an equilibrium in the quantity of different bodies.

If all existing atoms had been endued with the motive powers of affinity and attraction only, in addition to the power of immobility or inertia, then would the atoms so endued, at the instant they were created and endued, and when the promulgation of the law was made defining the limits, and regulating the operations of such powers, have yielded to its dictates, obeyed the mandate, and congregated in definite proportions, forming the purposed substances; which would ever have remained unchangeable, imperishable, and immoveable.

But the all-wise creator invested the atoms of heat and light with the desire and power of equal diffusion; and by this endowment the motion of such atoms was established. He also rendered such power superior to the power of affinity, simple, aggregate and cohesive attraction, and immobility or inertia; and therefore in obedience to such laws, and in the exercise of that power, the atoms of heat and light become by transition from one body to another, the *primum mobile* of all bodies, and the atoms of which they are composed; and as is the perpetuity of the power so must be the perpetuity of the effect.

The law and power of gravity as relates to atoms, or bodies composed of atoms, is that which directs their motion towards the centre of the earth, and the ability to obey it; and this law and power is the same, as that which directs the desire and disposition, and confers the ability on the ponderable atoms to unite and form ponderable bodies upon and above the surface of the earth; and the terms gravity, and affinity and attraction are synonymous, inasmuch as the law and power of gravity, is but the obedience of single and congregated atoms, to the desire of that affinity which subsists between them and the nucleus atom of the earth; and the exercise of the power of attraction, to an endeavour to fulfil it: and although the exercise of the power of affinity and attraction, which induces the union of ponderable atoms for the formation of bodies upon, beneath, or above the surface of the earth, may appear to militate against the law of gravity, yet such is not the fact; inasmuch as the union of atoms to form bodies upon, beneath and above the surface of the earth, is but an obedience to the more powerful force of affinity and attraction, which subsists between those atoms which are remotely situated from the centre of the earth, and which causes them to unite together, than subsists between them and the nucleus atom of the earth; and when the influence of this superior power is expended, by the formation of the body to the limited extent of accretion, then does such body fall toward the centre of the earth, with a velocity proportionate to the accumulated force of the powers of affinity and attraction, which exists between the aggregate number of atoms composing that body, and the nucleus atom of the earth. To illustrate this theorem, we may refer to the apple, the fall of which suggested the idea, and led to the discovery or knowledge of the law of gravity.

The apple was compounded of ponderable and imponderable atoms; it possessed a nucleus atom; and to that nucleus atom there was an accretion of atoms—the accretion of the ponderable atoms being the result of affinity and attraction, and the accretion of the imponderable, the result of equal diffusion: the accretion of those atoms caused what is termed the growth of the apple, and the accretion continued to a definite and limited extent, and then ceased as relates to an increase of its bulk; and up to that point we find, that the formation of that body was the result of the affinity which subsisted between the nucleus atom, and the first atom which united with it by the power of attraction; and between those two and the next that joined them, and so on in continuation, until the united mass of atoms ceased to attract more; and the stem or stalk which held the apple united to the tree, and which conveyed the sap from the tree to the fruit, from which a portion of its component atoms were derived by accretion, having fulfilled its office, and no longer able to support the apple; it fell from the tree toward the centre of the earth, with a velocity proportionate to the height at which it was situated, and the amount of its constituent ponderable atoms, in obedience to the law of gravity; or in other words, in obedience to the law of affinity and attraction, subsisting between it and the nucleus atom of the earth.

The law and power of recession to which the atoms of heat and light are subject, renders them imponderable; and not merely negatively imponderable, but confers on them a diametrically opposite property; and therefore as all bodies are compounded of imponderable and ponderable atoms, their specific gravity is proportionate to the relative proportion of the imponderable and ponderable atoms of which they are composed; and by the agency of the imponderable atoms, may the power of gravity, or affinity and attraction, be said to be partially or totally neutralized.

The law and power of recession from the earth, to which the atoms of heat and light are subject, is secondary, or inferior to the law and power of equal diffusion to which they are subject; and by this arrangement, the supply of heat and light to the planetary system is circulatory: the transition being from the sun to the planets in obedience to the law of equal diffusion, and the transition from the planets to the sun being in obedience to the law of recession.

INCOMPRESSIBLE, *not to be pressed in less space.*

The power of affinity imparted to some classes or species of atoms, or that desire with which they are endued, to unite with each other, is a systematic and symmetrical tendency, regulated, limited, and controlled by the almighty artificer; and the resulting effect is, the formation of an innumerable variety of substances, formed by the union of atoms, collected together in one mass by the power of attraction of aggregation, which power is also defined, regulated, and limited by the same being: hence the fiat that commanded the formation of substances from atoms, and invested those atoms with a limited and defined power of self-arrangement, granted it in perpetuity; and the machinery of production, destruction, and reproduction, which was devised, planned, executed, and set in motion by the all-wise machinist, still continues, and ever will continue to move in order, harmony, and superlative perfection.

The formation of atoms, and their investiture with a defined, well regulated, and limited power, was for the purpose not only of production, destruction, and reproduction of substances in all the endless variety of form, size, color, &c. but for the furnishing also those substances with various properties, subservient to the purpose of their formation, among which properties may be enumerated those of incompressibility, elasticity, &c.

Incompressible solid bodies are those, the atoms of which are so united together by attraction of cohesion, as to leave no unoccupied space between them, or occupied other than in the interstices presented by their union, in consequence of their spherical form.

Thus as the atoms are solid and indestructible, and they are all united in as close contact as is possible; no force however great can be applied, that is capable of compressing such bodies into a less space. But there are many bodies called solid, because all the atoms of which they are composed, are united by attraction of cohesion; and they are so designated to distinguish them from such bodies whose atoms are not united by attraction of cohesion, such as fluids and gases; and yet such bodies are compressible, because the atoms of which they are composed, are not united together by close contact in all their accessible points; and in the formation of such bodies, the cause of prevention to close and intimate contact, is the intervention of some extraneous substance. Hence we find wood compressible, because in its formation, a circulating fluid is employed; and the growth or formation of wood is effected by the accretion of atoms from such circulating fluid, to the atoms constituting the wood already formed, resulting from the affinity between, and the attraction of the atoms constituting a portion of such wood, and a portion of the atoms of the circulating fluid; and as while the wood is in a state of formation or growth, the circulating fluid continues to occupy the channel or course through which it is destined to flow; so when such fluid has ceased to flow, and is abstracted from such channels, they are then occupied by atmospheric air, and any powerful force sufficient for the purpose, applied to such wood, whose channels are filled either with a fluid or air, will first cause the exudation of such fluid or air, and next the collapsion of such channels, and consequently the compression of the wood to an extent limited only by the close and intimate union of every ponderable atom of which it is composed, in all their accessible points.

The growth of wood is by an internal accretion, but the growth of a stone and a variety of other substances, is by external accretion.

The ponderable woods are less compressible than the lighter, because the latter have more veins or channels in their structure than the former, or in other words are more porous; and in any given equal dimensions, wood of close texture is compounded of a much greater quantity of ponderable atoms, than wood of an open or loose texture, and hence its superior weight.

Water is incompressible at 32 degrees of heat, because the interstices between the ponderable atoms of which it is composed, are filled with just a sufficient quantity of atoms of heat, to prevent the ponderable atoms from being united by attraction of cohesion, and not by a quantity more than is sufficient for such purpose; and as consequently no heat can be expelled from such water by pressure, therefore its bulk is incompressible.

Water of a higher temperature than 32 degrees is incompressible, provided the surrounding media is of the same or of a higher temperature; for although there are a greater number of atoms of heat mixed with the ponderable atoms of which it is composed, than is sufficient to fill the interstices; and consequently those ponderable atoms are as remotely situated from each other, as the surplus number of atoms of heat can separate them; yet will not the most powerful pressure cause the exudation of such surplus atoms of heat, because the surrounding media cannot receive them, in consequence of its equality or superiority in temperature; for no pressure can be equal in intensity, to the force which is exerted by an atom of heat to maintain an equality of temperature; and therefore as none of the atoms of heat can be expelled, consequently the ponderable atoms cannot be pressed closer to each other.

Water of a higher temperature than the surrounding media, may doubtlessly be compressed by pressure, by causing the expulsion of as many atoms of heat therefrom, as is sufficient to reduce its temperature to an equality with the surrounding media, and at the same time cause the ponderable atoms which had been widely separated from each other by such atoms of heat, to approach in closer contact with each other, in consequence of the removal of the cause of their separation; but it is scarcely necessary to remark, that such an operation would be quite superfluous, inasmuch as the abstraction of such heat by the surrounding media, would be quite equivalent to any pressure.

Atmospheric air and the various gases are compressible, because they are compounded with ponderable atoms situate at great distances from each other, being so placed by the large quantities of atoms of heat commixed therewith; and pressure will expel heat therefrom, proportionate in quantity to the intensity of the force employed; and in proportion to the quantity of heat thus expelled, will be the extent of the compression. And such compression may be effected in surrounding media of the same or a higher temperature, provided the medium in close contact, is surrounded by media which is capable of receiving the heat which is expelled by pressure; for as the pressure forces into the medium a portion of the atoms of heat, its temperature is thereby increased, and the media in contact with such medium abstracts the surplus; and by the connecting media the atoms of heat expelled become diffused. But the moment that such pressure is removed from the air or gas, from which such heat has been expelled, an instantaneous return of heat thereto, to the same amount as has been expelled, will take place, and this restoration of heat will cause its expansion to its original bulk.

Atmospheric air and the various gases are called elastic gases, because they are capable of being compressed by mechanical pressure, and because the moment they are relieved from such pressure they are restored to their original bulk. The result of such pressure is the expulsion of heat from the air or gas, which allows the ponderable atoms of which it is composed to be compressed closer together; and the result of the removal of the pressure power, is the instantaneous readmixture of the same amount of heat as had been expelled, with the ponderable atoms, and the consequent expansion or removal of those ponderable atoms to the original distance at which they were situate from each other, and consequently the restoration of the air or gas to its original bulk.

All substances are either solid, fluid or gaseous, and each class is compounded of a definite number of ponderable atoms commixed with a definite number of atoms of heat; the amount of which is called the caloric of solidity, the caloric of fluidity, and the caloric gaseous; and the amount of the constituent atoms of heat appertaining to each body, is the result of a peculiar component proportion and arrangement of the several species or classes of ponderable atoms of which each body is composed, as is ordained and appointed by the creator of all things; and it is immaterial by what means the amount of such heat is diminished, whether by exudation or abstraction, as such or the same quantity of heat will always return to such bodies, as a natural and inevitable restoration of them to their constituent amount, whenever the surrounding media is competent to furnish the supply needed, agreeable to the law of equal diffusion to which heat is subject, and while the ponderable atoms of which such bodies are composed, exist in the relative amount, proportion, and situation to each other. The present offers an opportune occasion to mention, that the law of equal diffusion to which heat is subject, applies to the constituent or what is termed latent heat of bodies, as well as to the surplus or active heat, which pervades bodies; and herein will be perceived the admirable arrangement, that while the amount of active heat is always sufficient for ordinary purposes, every body contains a sufficient quantity of latent heat subject to the liability of being liberated and rendered free and active by the partial or total decomposition of the body, and thereby furnish an extraordinary supply of active heat, for every case of need and emergency, and when the supply of active heat from the sun, is not adequate to the immediate wants and purposes of man.

INEBRIATE, *to make or grow drunk, to stupify.*

All vinous fermented fluids in a state fit for consumption, are composed of a portion of the unfermented or undecomposed extract of some fermentable material, of carbonic acid, and of spirit. When such a fluid is received into the stomach its temperature is raised to an equality with such receptacle, which may be aptly compared both to a fermenting tun, and a still, and the brain to a receiver both of carbonic acid gas, and the spirit which is expelled therefrom; and the various membraneous canals, are the medium of its conveyance thereto. At such a temperature the fluid is subject to distillation, and the spirit ascends to the brain, imparting to the innumerable nerves, that terminate in extensive ramification, through the medullary substance of which it is composed, an agreeable and healthy tone and vigour, provided the impartation is not to excess, and which is conveyed to the utmost extent of the animal system commixed with the nervous fluid. The carbonic acid existing in the fluid is converted into gas, by the impartation of heat to it from the stomach, and which rising to the brain, operates upon it to an exhilarating extent, provided the quantity conveyed is not in excess. As such fluids are composed of unfermented extract, varying in amount, in proportion to the extent to which the previous fermentation to which it has been subject has been conducted; and as such unfermented material contains much carbon, a union of such acid as may be in the stomach therewith will occur, and the result will prove the formation of more carbonic acid, and which being subsequently converted into gas, a yet larger quantity will be conveyed to the brain; and thus by the joint operation of distillation and fermentation effected in the stomach, may it be compared to a still and a fermenting tun.

If therefore the stomach is charged with an immoderate quantity of a weak fermented fluid, or a smaller quantity of a strong fluid, the conveyance of spirit and carbonic acid gas to the brain will be in excess, and inebriation will be the result.

The quantity that may be termed immoderate, is proportionate to the effect produced upon the individual who consumes it. A very small quantity may be sufficient to inebriate those who are unaccustomed to the use of fermented fluids, or who are constitutionally weak, and whose habits, labours, and a variety of circumstances, do not extensively exhaust the animal system, and such persons need but a very small supply of fermented fluids. But those who are of a robust constitution, have been much habituated to its use, take much exercise, or are accustomed to hard labour, can consume a large quantity without the liability of being inebriated; and it is not the judicious and proportionate consumption to its need, that is at all injurious, but which on the contrary is truly beneficial.

The effect of carbonic acid gas upon the brain of some individuals is both unpleasant and injurious, and to such persons the consumption of fermented fluids is not salutary, particularly such as are replete with carbonic acid gas at the time of its consumption, or are capable of producing much, from the possession of much of the material which is capable of producing it, resulting from its incomplete fermentation.

INFLAMMABLE, *easily set on fire, ignitible.*

The presence of carbon and hydrogen in the substances, and oxygen in the atmosphere, are the requisite elements of inflammability, and the conditions to ensure its total or partial combustion.

The greater the number of atoms of carbon and hydrogen which a body contains, and the more suitable the adaptation of arrangement of those atoms, to combine by superior affinity with the atoms of oxygen of the atmosphere, than exists between such atoms and the other atoms of which the body is composed; the greater is the inflammable properties of such body.

The rapidity of combustion of a body, is proportionate to the number and suitable arrangement of the atoms of carbon, or hydrogen, or both, which are contained in that body; to the force and power of affinity and attraction which holds those atoms in combination with the other atoms of which the body is composed; and to the quantity of oxygen which may have access to the body in a state of combustion by medium of the atmosphere.

The greater the quantity of carbon and hydrogen which a body contains, the greater is the amount of heat evolved in the combustion of that body, arising not merely from the liberation of latent heat contained within the body, and which is thereby rendered active, and available to various purposes, but also from the decomposition of an immense quantity of air, in the supply of the necessary quantity of oxygen to support the combustion of that body; such decomposition liberating an extensive quantity of latent heat appertaining to such air as its constituent portion, and rendering it free.

In the combustion of fuel for the liberation of latent heat, and its conversion into an appropriating state of activity, with the utmost economy, in connection with the purport of its impartation, and the required effect; a competent knowledge of the constituent composition of various descriptions of fuel, the quantity of latent heat they contain, the state and condition of the atmosphere best adapted to support combustion, is highly necessary and advantageous.

In the appropriation of heat resulting from the combustion of a body, the rapidity of combustion should be proportionate to the purpose for which the impartation is intended; and the mode of impartation the best adapted for the accomplishment of the intended purpose; and every consumer of fuel is deeply interested in the obtainment of that knowledge, by which he can best accomplish his purpose, and at the least cost.

INSOLUBLE, *not able to be dissolved.*

As the dissolution of every known substance is practicable, the term insoluble is a superfluous word, as relates to strict application, but a proper term as relates to particular circumstances. Thus we talk of the soluble and the insoluble materials of malt, from which we understand, that portion of the constituent atoms of malt which will amalgamate with water, and the remaining portion which will not; but we are not to infer therefrom, that the portion which is insoluble in water, is not soluble in some other menstruum.

To dissolve the whole of that portion of the constituent substances of which malted or unmalted grain is composed, which are soluble in water; it is necessary to use water of suitable quantity, of a right temperature, and successive portions, in the way of infusion.

The natural state or condition of water which is used for the purpose of dissolving the soluble substances of grain, will often admit of improvement, either by an abstraction of that which it contains, which is inimical to such solution, or by the addition of that which is favorable and conducive to the operation. Every brewer therefore should possess a competent knowledge of the classes of atoms, and the relative proportion of each of which pure water is composed, and the adventitious substances that are usually chemically combined or simply mixed with the water which he uses for the purpose of brewing: and in addition he should also know, if either of the extraneous substances blended therewith, will prevent the solution of any portion of those component materials of the grain, which are soluble in pure water of a correct temperature administered in right proportions, and under favorable and suitable circumstances; and if he discovers the presence of one or more substances which militate against a competent solution, he should know how to abstract them; and he should also know if the impartation of any agent that is capable of abstracting the extraneous substance, will prove a greater obstacle to solution than the substance removed, or whether its addition will facilitate and aid the operation: and in drawing his conclusions as to solution, he should not forget the consequences as relates to fermentation.

A proper preparation of grain previous to the process of solution, and a knowledge of its condition and quality is necessary.

The solution of the soluble material of grain is not to be effected instantaneously or rapidly; and the conditions to be observed to ensure a solution of the whole and in right proportions, are a suitable menstruum, of a correct temperature, administered in proper quantity, for a proper period, under suitable circumstances, and renewed at intervals, at variable, yet suitable temperatures.

That the menstruum first administered should be of a correct temperature is most important; inasmuch as the success of ulterior operations is greatly dependent on the correctness of the first mashing heat; and a failure in the adoption of a right heat in the first stage, will render a correct subsequent process but of little utility, as a "good end will not remedy a bad beginning." Nor will a good beginning be a compensation for a bad end. An advantageous solution, is the result of a correct system, rightly pursued in every stage of the operation.

If the quality, state and condition of grain, and its temperature were always the same, the most favorable heat of the menstruum to effect solution might easily be discovered, and a standard established for the universal use of brewers; but as both one and the other is ever variable, so must the temperature of the menstruum be varied, to suit the variable quality, state, condition, and temperature of the grain.

If the temperature of grain was invariably the same at all times, the chief difficulty in the way of ascertaining correctly the proper temperature of the menstruum for the first mashing process would not exist; but as malt thrown fresh from the kiln may be of a much higher heat than such as has been exposed for a long period to the atmosphere, as grain crushed or ground is thereby increased in temperature, and as grain is subject to as extensive a variation in temperature as the atmosphere to which it is liable to be exposed, so it is necessary that the first mashing heat should vary as extensively, as may be induced by varying circumstances, which every brewer should comprehend and take cognizance of, and avail himself of that useful and indispensably necessary rule, which I have furnished in my Practical Treatise on Malting and Brewing, in order that he may obtain not only a large produce of extract, but also of a proper quality, which can only be effected by a right heat.

IRREMEDIABLE, *not to be remedied or cured.*

"An ounce of prevention is better than a pound of cure," is an adage that should not only be indelibly, but so prominently impressed on the mind of every human being, as ever to be present to thought, previous to the performance of any action.

To remedy, is not to undo and do again properly, that which should properly have been done in the first instance, but an attempt to repair, alleviate, or avert the mischief that has occurred, or may result from an improper performance.

To exercise the necessary care and caution in performance, and to obtain the requisite knowledge and practical skill correctly to execute, is far better, and more desirable in every sense, than to be subject to the administration of various remedies, in order to avoid the ill consequences of a wrong performance; and the following adage, "Idleness takes most pains," is truly applicable to such persons, whose actions are thoughtlessly, carelessly, or ignorantly performed, and whom it costs more time, trouble, care and anxiety in the application of the required remedies, than it would to have taken more pains in the execution of the details, and whose loss resulting from ignorance, may amount to more than the cost of obtaining the knowledge that would have enabled the avoidance.

It is a matter of just reproach, due to too many in every department of trade and manufacture, that they will not endeavour to render themselves masters of a rudimental knowledge of their business, as well as the practical fulfilment of its duties. They first learn that which should be learnt last.

Those to whom this work is more particularly addressed, are by no means exempt from the imputation, nor do we in condemning others, forget the large portion of censure due to ourselves: but "better late than never," for it can never be too late to endeavour to obtain a knowledge of first principles, and to turn that knowledge to the best account in the way of business.

Those who began to learn their business at the right end, cannot be insensible to the advantage of possessing a good stock of remedies suitable for any unavoidable or avoidable evil that may occur; for although they may very properly endeavour to avoid the necessity for their use, yet will they very willingly adopt and apply them whenever they are absolutely needed.

Those whose objections are the strongest to an idle, careless and ignorant system of conducting business, are much the most likely persons to be acquainted with suitable remedies, and to apply them when needed; because the same causes which have operated to stamp a person idle, careless, and ignorant, and prevented his obtainment of the knowledge to prevent evil, have also operated to prevent his attainment of a knowledge of useful remedies for unavoidable or avoidable evils, and to deprive him of the disposition to use them, had they been forced upon his possession without seeking them. And it is those whose apathy, listlessness, and want of information, are ever involving them in difficulties, are the first to cry out, "the case is irremediable."

ISINGLASS, *a kind of glue made from the intestines of a fish.*

The decided preference which the public have for some years given to ale and porter, that is perfectly free from the presence of much or any portion of acid, and their determination to approve of none but what is brilliantly transparent; and the incapability of brewers generally to obtain the required transparency naturally, within the period that freedom from acidity can be ensured; has induced the extensive use of isinglass, among those who from convenience or necessity, require an artificial mode of effecting such object, at the expiration of a few days from the day of brewing, upon or shortly after the termination of the first or foul stage of fermentation.

It is usual to dissolve such isinglass in stale beer, as being the most convenient and suitable solvent, and the solution is termed finings; and being strained and diluted to a proper consistence with stale or mild beer, it is imparted to the beer which is to be rendered transparent, by pouring a sufficient quantity into the bung hole of the cask, and diffusing it by a slight agitation with a short stick.

The mode of its operation in effecting transparency, is by attracting all the floating particles of coagulated gluten, which pervades and causes the opacity of the beer, and drawing them to itself, and which attraction is induced by an affinity subsisting between the isinglass and the coagulated gluten. Having performed such an operation, the isinglass and gluten will be held together by attraction of cohesion in a floculent form, and will float on the upper surface of the beer, or be suspended below the surface, or lie at the bottom of the cask, as the difference in the specific gravity of the mass compared with that of the beer may be greater or less. The force of attraction of cohesion subsisting between such isinglass and gluten is very slight, and liable to be overcome by agitation, and a second fermentation, if the force of motion of the carbonic acid gas generated by a second fermentation, is superior to such attraction of cohesion.

If dissolved isinglass is inserted in beer that is in a state of second fermentation, and if the intestine motion resulting therefrom, is superior in force to the power of attraction between the isinglass and the floating particles of coagulated gluten, the purport of its insertion will not be accomplished.

Every brewer should be well acquainted with the means of rendering his beer by the first fermentation fit to receive the isinglass; with the proper state and condition of beer to receive it, the proper time to apply it, the necessary conditions to render it effectual, and the subsequent measures that are necessary to be pursued to cause a continuance of its efficacy.

KNOWLEDGE, *understanding*, *skill*, *learning*, *notice*.

The terms employed to express the meaning of the word knowledge, may be paraphrased thus. To *understand* how to apply with *skill*, that *learning* to a useful purpose, which we have derived from a *notice* of the written or verbal information communicated by others; the visual intelligence derived from the observation of men and things; and the deductions and conclusions derived from the operation of reason and reflection, in unfolding and developing truth, by the mental analysis of all that is presented to notice.

The great and general defect in the education of youth, both at school, in trade, and in the manufactory, is, that they are not taught, but merely allowed the opportunity to learn if they have but the inclination.

To select the malthouse and brewery as examples in proof of such assertion, how few are those who are called upon to perform important and difficult operations in chemistry therein, competent to the task, or who possess the least pretensions to competency, as relates to any knowledge which they have obtained at school, or subsequent to removal therefrom, in the science of chemistry, or are even conscious that their labours are chemical.

Does the maltster teach his pupil to analyze the grain he malts, to ascertain its composition, to divide its substances, and learn their names, qualities, properties, and proportions; to subdivide the substances into species of atoms, and to discover their amount and tendencies? Does he teach him to analyze the water in which he steeps the grain, in order to discover the extraneous substances which are chemically blended or simply mixed therewith? Does he explain to him the properties of those substances which he may discover, and point out their ability to retard or facilitate germination? And does he reveal the various laws of affinity, simple and aggregate attraction, and attraction of cohesion that govern and direct all the tendencies and motions of ponderable atoms and the powers that controul, direct and stimulate the action of the imponderable atoms? Does he inform him of the internal changes to be effected in the structure and composition of the grain by the process of germination; the various combinations of atoms that must occur, the abstractions and additions that must be made, and the transitions which must be effected between the grain, the water, and the atmosphere? And does he superadd to all this, and much more that might be enumerated, the operation of heat and light in effecting by agency, the various transmutations which occur in the process of germination? In fine, does he first convey to the mind of his pupil, all that theoretical information which is sufficient to enable him to comprehend the subject of his labours, and then lead him on to a practical verification of the truths which he has endeavoured to inculcate, by an operative exposition of their fulfilment in the several stages of the malting process? No, certainly not! He possesses no such knowledge himself, and therefore cannot impart it to others. His knowledge is all practical and traditionary; and just what he has learnt, his pupil (if so he may be called) may learn also. He tells him to notice his doings and to do as he does, and thus in one sentence he performs his task of instruction for ever, leaving his imitator instinctively to learn that which he has similarly learnt; and the knowledge obtained by the type, is to the acquirements of the original, in the same ratio, as the animal senses of seeing, smelling and feeling, are more or less acute and sensitive in the one than in the other.

And can we tell a better tale for the brewery? can we shew that the uneducated brewer, who although he may have become affluent by plodding industry, has ever felt during his progress, the aching void resulting from his own ignorance, and lamented the numerous losses which he is conscious he has sustained for want of knowledge? And can we shew that he has procured for his son, that knowledge of which he knows his own deficiency? He may have placed him at an expensive school, and may have expected a brilliant result; but science is not taught at such seminaries, (as a general rule) but pride and indolence are too often deeply inculcated; and the youth who too well knows the length of his father's purse, who burns with desire to spend its contents in frivolous pleasures, and aims not to gain but to enjoy, is not the one to wade through (to him) the dreary intricacies of science. He leaves the prison house of learning, gilt upon the superfices, with scraps of greek and latin, which he can dance into oblivion to the tunes of waltzes, quadrilles, and gay cotillions; and thus he issues into life, fit for the gun, the hounds, the theatre, or ball, but not for the copper's side, to which his anxious parent had destined him; and thus the youth, whose knowledge mischievously excels his father's ignorance, is first admitted to the brewery, placed at the most important post, and by omission and commission, does more mischief in one year than half a century will cure. If this picture is painful to look upon, yet is it a faithful, though faint delineation of the case, condition and circumstances of many.

"Necessity is the mother of invention," and many there are who being urged on by the keen lash of necessity, will outstrip their fortune favored contemporaries in the attainment of useful knowledge; but it is much to be regretted, that the generality of this class, commence their search among the branches, for that nutritive sap of the fair tree of knowledge, which may best be obtained from the trunk; and they obtain a mass of practical information only, mixed up with many empiric remedies, instead of that sound theoretical knowledge, which leads to correct practical operations, and supersedes the necessity of resorting to remedial measures.

LATENT, *secret, private, hidden, concealed.*

The terms latent and active heat so frequently used by chemical writers, may be construed by some readers, as intended to designate distinct species, or two classes of atoms of heat, or heat under different circumstances, possessing two distinct properties; and as all error should be guarded against, and the learner should possess clear and correct views, as to the meaning intended to be conveyed by expressed terms, it may be both desirable and necessary to explain, that the atoms of heat are not divisible into classes, nor do they possess different properties; but that the term latent is applied to such atoms of heat, as are intimately blended with the ponderable atoms of which a body is composed, and which form a portion of the constituent atoms of such body. Thus we say, that the caloric of fluidity of water is 140 degrees, because we find, that from a pound of water at 32 degrees of thermometric heat, 140 degrees of latent heat must be abstracted therefrom, before such water can be converted from a fluid to a solid state; and after such abstraction, the thermometric heat of the solid water (ice) is the same. The heat thus abstracted, was called latent previous to the abstraction, and active subsequent thereto. The term latent therefore as applied to heat, must be considered as merely intended to designate that portion of the atoms of heat, which are blended with the ponderable atoms of the body in a temporarily inactive state; and that when it is said that latent heat is converted into active, it is not meant that a transmutation of any property of such heat has occurred, but that it has been impelled from an inactive to an active state, by the operation of the power, induced by the law of equal diffusion.

All bodies may be termed reservoirs or magazines of heat, and the heat which is held in combination with such bodies is called latent, while remaining inactive therein; or active, while in motion therein, or in a state of transition therefrom.

If the ponderable atoms of a body are in a state of cohesion, the reservoirs for the reception of heat which it furnishes, are the interstices only, which result from the union by close contact of the ponderable atoms, and their peculiar form; thus if they are spherical, (which we presume they are) or of any other shape, the dimensions of the interstices will be proportionate to the magnitude or arranged position of the ponderable atoms.

If the ponderable atoms of a body are not in a state of cohesion, they furnish a reservoir for heat, of a capacity coextensive with the limits of aggregate attraction, by which the ponderable atoms are held together within the sphere of such attraction.

All bodies will yield a portion of their heat to another body which possesses less than itself, and if the ponderable atoms of which such body is composed are not in a state of cohesion, they will approach nearer to each other on the departure of such heat, and their proximate motion will be proportionate to the quantity of heat which may have departed; and the departure may occur to an extent sufficient to enable the ponderable atoms of such body to unite in close contact with each other, and such an operation is sufficient to convert a gaseous or liquid fluid into a solid; and after such conversion, a yet further abstraction of heat may be effected, by withdrawing it from the interstices; and all the heat thus withdrawn was denominated latent previous to its removal, and active the moment that its motion commenced.

Heat thus abstracted from bodies, fulfils the law of equal diffusion to which it is subject.

Bodies will yield their heat on being partially or totally decomposed, by an abstraction or separation beyond the sphere of aggregate attraction, of a portion or the whole of the ponderable atoms of which they are composed.

Take away a single ponderable atom from a body, and, comparatively speaking, you open the door of the magazine which contains the atoms of heat, and as many of those atoms as appertain by the law of constituency to that ponderable atom which is removed, will leave the interstice and accompany such atom.

Heat is not only subject to the law of equal diffusion, but to another law, which may be termed the law of constituency or composition, whereby every ponderable atom, whether in a state of rest or motion, is accompanied by as many atoms of heat as are due to it agreeable to that law, when the covenants of that law are not contravened by the fulfilment of the law of equal diffusion.

By the law of constituency or composition, the atoms of heat which belong to a body as its constituent portion, have a tendency to remain at rest: for being invested with a power to unite in definite quantities with the ponderable atoms, and accompanying the latter in their accretion to, or formation of other bodies, they participate in the same tendency to remain at rest as the ponderable atoms, until called into activity by the superior law of equal diffusion, or the partial or total decomposition of the body with which they are blended; and until called into activity by either or both these causes, such heat may with propriety be termed latent.

LIGHTNING, *the flash which precedes thunder.*

Lightning is considered as the evidence and result of the inflammable combustion of mixed gases; and although the powers of the mind are, or may not be adequate to determine the names, the properties, and proportion of the gases, which by union are subject to spontaneous combustion, and the combustion of which is productive of the flash, yet a well founded supposition may be indulged in, which is supported by strong analogy.

The spontaneous combustion of oxygen and hydrogen gases, when mixed in certain proportions in conducting experimental processes, are a sufficient authority for the supposition, that a spontaneous ignition of an admixture of such or other inflammable gases, in the upper regions of the atmosphere, is the cause of their combustion, producing the result called lightning, and the sound called thunder.

We can easily imagine, and furnish as an hypothesis, the circumstance of unusually large quantities of oxygen being emitted from trees, &c. in a state of active vegetation, and unusually large quantities of hydrogen gas emitted from stagnant marshes and other sources in a hot summer's day, induced by the excitative and accelerating influence of heat, and other favorable concurring causes; and that by the admixture of such gases in explosive proportions, spontaneous ignition occurs; rapid and extensive combustion ensues; light and heat are released from their state of latency and rendered active, quit the position they occupied, and thereby create an extensive vacuum, and the immense mass of atmospheric air which rushes in from all sides with an inconceivable force, meets with a tremendous crash, and creates a sound, enduring only to the distant ear.

The forked and stream-like appearance of lightning, and the great distance to which a flash extends, implies the existence of a ramified train of the gaseous fluid, and that the spontaneous ignition at one point, is instantaneously communicative to the extended vein or sheet-like train.

As water is compounded of oxygen, hydrogen and caloric, in definite proportions, and as an admixture of oxygen and hydrogen gases in such a proportion as would render the ponderable atoms of oxygen and hydrogen of the proper amount to constitute water, would only be prevented from forming water by the presence of more than the constituent amount of caloric of water, it appears therefore to us as a necessary consequence, that if as much caloric is abstracted from the mixed gases, as is sufficient to reduce its quantity to the constituent amount of water, that the formation of water would necessarily ensue. Agreeable then to this theorem, it appears to us rational to conclude, that the extraordinarily abundant fall of rain or hail which often occurs during a thunder storm, is the result of a formation of water, by the admixture of oxygen and hydrogen gases in definite proportions, their consequent spontaneous combustion, and the abstraction of caloric to an amount sufficient to reduce the gaseous fluid to a liquid or solid; and on the same principle it appears to us, that the formation of ærolites may be accounted for—the decomposition of inflammable gases by combustion, causing an abstraction of caloric therefrom to an extent sufficient, as to admit of the ponderable atoms which form a constituent portion of those gases, to unite together by the power of attraction of aggregation and cohesion, thereby forming solids.

The effect of lightning in causing the acetification of beer, it may be impossible to account for; and the most plausible yet inconclusive opinion which can perhaps be offered, is, that the train of oxygen gas in a state of simple mixture with the atmosphere, and mixed with hydrogen gas in a state of explosive mixture, being situated in the vicinity of such beer, the impartation of the oxygen may be the result of the rapid decomposition of the mixed gases, to an extent much greater than could occur by the usual operation of the laws of affinity and attraction, inducing the union of such oxygen with the carbon of the beer.

MALT, ***grain steeped in water, germinated and dried on a kiln.***

Several species of grain are occasionally malted, such as barley, wheat, oats, rye, &c. but barley is usually devoted to the purpose, as the best adapted for that, and its lesser suitability for other purposes.

The purport of steeping grain in water, is to cause the commencement and continuation of the process of germination; and the chemical action induced by the immersion of grain in water, is to bring within the sphere of mutual attraction, those constituent atoms of the grain and water which have an affinity for each other, more powerful than the affinity which holds them in combination with the other atoms of which the two bodies are composed, and thereby to effect their combination, and the various organic changes which ultimately occur.

The affinity between the oxygen of the water, and the carbon of the grain, being stronger than the affinity between the oxygen and hydrogen of which the water is composed, and between the carbon and other atoms of which the grain is composed, these two species or classes of atoms being placed within the sphere of mutual attraction, they unite and form carbonic acid.

But the union of the carbon and oxygen, and the formation of carbonic acid, is not sufficient to cause the commencement of germination, and is only a preliminary step toward it; inasmuch as the process of germination consists in changing the composition of the interior substances of the grain; and for this purpose the addition and the abstraction of atoms from water and the atmosphere are necessary.

The addition of atoms are necessary for the purpose of abstracting those which the grain possesses, which are superfluous for the composition of the new substances to be formed; and the addition of atoms are necessary, for the purpose of combining with a portion of the resident atoms of the grain, to constitute the new substances which are required.

The creation of carbonic acid being effected, as a preliminary measure to the commencement and continuation of the process of germination, heat is now required to convert such carbonic acid into gas, and a sufficiency to render it specifically lighter than the surrounding atmosphere, in order that its evolation from the grain may occur; and the grain itself is the reservoir which contains a portion of the heat in a latent state, that is needed for the purpose, and the water the residue, and which in obedience to the law of constituency or composition, unites with the new compound, and thereby renders it specifically lighter than the atmosphere, and consequently the evolation of the carbonic acid gas ensues.

It may be here objected that chemical writers state, that carbonic acid gas is heavier than atmospheric air, and therefore our statement may appear contradictory to theirs; but it must be remembered that they also state, that water is much heavier than air, and yet we know that it may be rendered specifically lighter than the atmosphere, and thereby be enabled to ascend therein.

Thus by such apparently simple, yet really wonderful means, is the commencement of the process of germination effected, and the admirable contrivance of rendering all bodies the magazines of those principles, which are requisite to effect by assistance, their partial or total decomposition, is made manifest, and the consummate wisdom of the contriver, is unfolded to the minds of those who endeavour to scan his works, and can trace "through all the works of nature, nature's God."

The continuation of the process of germination, is effected by the combination of atoms of oxygen derived from the water and the atmosphere, with the carbon of the grain; and this derivation of oxygen for the purpose, from the two sources, is simultaneous and necessary; inasmuch as the supply of heat from one source alone, would not be sufficient to render the carbonic acid created gaseous, and of less specific gravity than the atmosphere, which is to be the recipient medium, when its evolation occurs.

The water supplies the most oxygen in the ratio of the quantity employed, and the atmosphere the most heat, because the constituent proportion of oxygen in water, is much greater than in atmospheric air; and the amount of latent heat appertaining to air, is much greater than what belongs to water.

As the impartation of oxygen from the atmosphere is indispensably necessary to the continuance of the process of germination, it may be supposed that when the atmosphere is charged with an excess of oxygen in a state of simple mixture, that the process will be facilitated and accelerated by the extra impartation; and it may be so, when the aid of active heat, accompanying the extra supply of oxygen, converts the carbonic acid thereby created into gas of sufficient levity to enable its evolation; but as the supply of heat from the decomposition of oxygen gas in the ratio of the oxygen imparted, is very much less than the quantity of heat supplied from the decomposition of air, in relation to the quantity of oxygen it supplies, so the impartation of oxygen, from that which is present in atmospheric air in a state of simple mixture, unaccompanied by the required quantity of heat, may prove injurious instead of beneficial.

The combination of all the atoms of carbon and oxygen which are placed within the sphere of mutual attraction, does not immediately occur, because they cannot immediately have access to each other; and the question may be asked, if the quantity of water imbibed by a grain or seed of corn, is the resulting effect of a mutual affinity existing between the atoms of which the grain or seed of corn is composed, and the atoms of which water is composed, and that the absorption is proportionate to the extent of the power of affinity exerted, how is it that an immediate combination in close contact of the several classes of atoms between which the affinity exists does not occur? The reply to which is, the atoms composing the interior of the grain or seed of corn, are united together by attraction of cohesion, and are consequently not in a state of freedom to leave the grain, nor can they leave, until induced by a superior power to attraction of cohesion; while the atoms of which water is composed, are not united by attraction of cohesion, but by aggregate attraction only; hence as the two forces that hold the atoms of the grain together, are superior to the single force that holds the atoms of the water together, so the forces employed by mutual attraction being as two to one in favor of the grain, the resulting motion is the water to the grain, and not the grain to the water. Then as the atoms composing the grain have not moved, and the atoms composing the water have, the total amount of the substances within the husk or skin of the grain, are in a state of simple mixture up to the period of the termination of the absorption of water; and at such period a chemical combination commences between the oxygen of the water absorbed, and the carbon of the grain, atom by atom, as the resulting acid is converted into gas, and evolates from the interior to the exterior, and from the exterior surface of the grain to the atmosphere; hence as the removal of the carbonic acid gas created is continuous, so is the combination of fresh atoms to create more of such gas continuous, and any attempt to impart more oxygen than can enter into combination with the carbon of the grain in progressive and regular succession, would be both useless and injurious.

The temperature of the surrounding atmosphere, and of the situation in which the process of germination is effected, is a case of considerable importance as relates to the speed and favorable conditions of growth: thus nature has wisely adapted the temperature of the earth, in which the process of germination is usually effected, to the most suitable temperature for its accomplishment; and she has rendered such temperature nearly invariable, and consequently the most suitable for the germination of the various seeds that are subjected to the process throughout the year, and when the temperature of the atmosphere is so extensively variable.

But it is not to be supposed, that grain situated in the earth, the temperature of which is little variable, will germinate at a medium and regular speed; for as a great portion of the supply of heat that is necessary to render the carbonic acid gaseous, which is created by the union of the oxygen from the atmosphere with the carbon of the grain, is derived from the atmosphere, so the lower the temperature of the atmosphere, the less must be the amount of heat imparted for such purpose, and consequently the more tardy must be the process of germination; and the greater the natural temperature of the atmosphere, so the greater must be the impartation of heat thereto, and consequently the greater must be the speed of the process of germination. Nor is the difference in the effect of impartation of heat from the atmosphere to the grain as the result of its decomposition, alone to be considered, but the effect of the abstraction of heat from the grain when at a lower temperature than the proper germinating heat, must also be taken into consideration; as under such circumstances, the air becomes an abstractive substance of that heat which is derived from the decomposition of the substances forming the body of the grain and the water which it has imbibed, and which should be appropriated to the conversion of the carbonic acid into gas, instead of an impartive substance of heat to facilitate and accelerate such conversion; or rather the difference between the amount of heat supplied by the air to the grain as the result of its decomposition, in the impartation of oxygen to the grain, and the abstraction of heat therefrom as the result of its low temperature, forms a balance in favor of the amount of abstraction, retarding the process of germination to an extent proportionate to the amount of such balance.

As the process of germination in the malthouse is, or ought to be, as close a copy of the natural process in the field, as it can be profitably conducted; so an imitation of the natural temperature of the earth should be endeavoured, in regulating the temperature of the malthouse.

To the eye of the close and attentive observer, it must be apparent that the germinating process proceeds most regular and favorable, when the temperature of the atmosphere is about the same as the earth; consequently as the malting process is an artificial method of conducting the germinative process to a limited extent, it must therefore be obvious, that the artificial system may be pursued with the most advantage, at the same temperature as the natural process may be most advantageously conducted.

We have before stated that the impartation of oxygen and heat from the atmosphere to the grain, is simultaneous with the impartation of oxygen and heat from the water imbibed by the grain; and that such is the case, must be evident to the eye of the practised observer, by the gradual diminution during the continuation of the process, of the water which was imbibed by the grain in the cistern; and it is ever the anxious wish of the skilful maltster, to regulate the expenditure of the water, so as to prevent its total exhaustion, previous to the accomplishment of the process to the required extent; and that its consumption should be in regular gradation, proportionate to the speed of the process; and hence the motive that induces the addition of water by sprinkling on the floor, when he discovers that his grain did not absorb a sufficient quantity of water in the cistern, or that its abstraction in the process of germination has been too rapid, and to too great an extent.

The carbonic acid gas which evolates from grain in a state of germination in the earth, meets with no impediment to a free and unrestricted escape, being swept from the surface of the earth by the current of air which passes over it; but in the malthouse, it frequently is restricted in its free escape for the want of an efficient ventilation, or a free circulation of air over the floors. The desire to preserve the proper temperature of the room, naturally induces the maltster to prevent the admission of much cold air, when the temperature of the external atmosphere is much below the most suitable germinating heat; hence he frequently finds himself in the awkward and unpleasant dilemma, of being compelled to make choice of one of two evils, either the admission of too much cold air for the purpose of expelling the carbonic acid gas, that broods as an incubus over his grain, and for the purpose of supplying it with the needful quantity of oxygen, and thereby retarding the process of germination by the abstraction of too much heat; or its exclusion, for the purpose of maintaining the requisite temperature of the room, and thereby experiencing all the evil results of a restricted evolation of the carbonic acid gas which is generated, and an insufficient supply of oxygen.

The purport of malting grain is to create saccharum or sugar, of which grain in an unmalted state possesses but a very small portion, and to reduce the quantity of gluten, of which it possesses too much for the ultimate purpose to which malt is devoted.

It is also the maltster's purpose to create as much saccharum as he can, and to lose none; and therefore he conducts the process of germination as well as circumstances enable him, and his judgment dictates, to the point where loss commences; and then he endeavours to terminate the process.

But the purpose of nature is different from that of man; her object is to create as much saccharum as she can, but it is for the purpose of nourishing or supporting the plumula or acrospire which is to form the future stem, that is to convey the nutriment for the formation and growth of the intended seed.

As the operations of man must always be subordinate to those of nature, he must shape his course in parallel direction with her's; and although he cannot deviate therefrom, yet he may stop short at any distance from her ultimate destination.

Thus as in germination the production of saccharum is more rapid than the appropriation, nature designing the formation of the nutriment previous to its need, and in sufficient abundance to supply the greatest demand; so man awaits the period, when he conceives the process has been conducted to the most profitable point to suit his purpose, and then causes its cessation, by expelling the residue of the water from the grain, by heat upon the kiln.

To terminate the process of germination, we still find the impartation of heat necessary, and the same agent which was requisite to assist in the accomplishment of the process, is required to terminate it; but in the first case, the impartation must be regular, and to a medium and gradual extent, while in the other, it must be comparatively rapid and to excess; yet must the rapidity of the impartation of heat to the grain upon the kiln, be gradually increased and continued to a limited extent.

The impartation of oxygen also is requisite in the process of desiccation on the kiln, for the purpose of imparting the required color and flavor; and to facilitate such purpose, a perforated kiln floor is adopted, and the mouth of the furnace is left open during the period of drying; and in some kilns, the sides of the furnace are formed of cast iron plates, and an aperture on each side of such plates is made in the wall, to which are affixed sliding doors to regulate the supply of air; and the purport of such mechanical arrangements, are to cause a large quantity of heated air to pass through the grain upon the kiln, the oxygen from which has not been abstracted to support the combustion of the fuel in the furnace; hence the motive for not closing the mouth of the furnace in order that a large quantity of air may pass over the fire, and may be raised in temperature thereby, without parting with its oxygen, the intent being to reserve it for impartation to the grain on the kiln; and the motive for the apertures on each side of the furnace, and the formation of its sides with cast iron plates, is to furnish an additional supply of heated air, to the grain on the kiln, which passing through such apertures sweeps off the heat which passes through the iron plates.

If the grain is weighed previous and subsequent to its being malted, it will be found that a great loss in weight has occurred, affording an indubitable evidence, that in the process, the amount of abstraction of ponderable atoms from the grain has much exceeded the quantity imparted.

The brief and imperfect theoretical view we have furnished of the process of germination agreeable to the design and limits of this work, will doubtlessly prove unsatisfactory to many, but which yet may suggest several improvements in the process of malting to those who may need them; and if failing to furnish them with all the information in this work, which they require, we must refer them to our Theoretical and Practical Treatise on Malting and Brewing for the residue.

MALTHOUSE, *a building for the manufacture of malt.*

The design for a malthouse should always be furnished, not only by a competent architect or builder, but by one who understands the theoretical and practical details of the process of malting: but it is probable, that there are but few persons who possess that compound and requisite knowledge; and the few, (if any) of the malthouses that are constructed on correct principles, fully evince both the need and the absence of it, among the usual projectors.

As the purport of this work is merely to furnish elementary and theoretical information and not practical, we shall refrain from pointing out the many and common defects and deficiences which are to be met with in the construction, &c. of malthouses, and from suggesting a few improvements that might be made, which are not to be met with in any.

MALTSTER, *one who makes or deals in malt.*

That so important a process as that of manufacturing malt, should be confided to men, not only destitute of a scientific education, but to many who have not received the lowest rudimental instruction, is a circumstance which does not perhaps cause much or any regret, because there may be but few who duly appreciate the loss they sustain, by being obliged to confide the manufacture of malt to an ignorant and unlettered maltster; or knowing no remedy for the evil, they may philosophically conclude, that "what cannot be cured, must be endured."

If a brewer is not well informed himself, and if he does not well understand and know how to conduct the process of brewing on right principles, and if he is unacquainted with the theory and practice of malting, he cannot be competent to judge of the capabilities and performances of his maltster.

A serious annual loss may be sustained by an intelligent and calculating brewer, from an inability to obtain an intelligent, careful, and industrious maltster; and although conscious of his loss, he experiences the mortification also in knowing that his case is remediless; and he may perhaps envy his intelligent neighbour who is experiencing an equal or greater loss, because he is blest with the happy ignorance of the fact.

Four evident impediments to an improvement in the system of malting may be mentioned; the laborious employment, the night work, the low wages, and the excise restrictions. The three first are sufficient to deter men of education from undertaking the employment, and the latter to prevent the employer from an endeavour to effect improvements that would be met with fiscal restrictions, and prevented by legal prohibitions.

To experience a difference of five pounds per quarter of malt, in the amount of extract obtained in brewing from such as has been made from grain of equal quality, or of the very same bulk by different maltsters, is by no means an uncommon occurrence; and if we calculate the average price of malt at 60s. per quarter, and the average product at 80 pounds per quarter, we shall find the loss per quarter sustained, if but 75 pounds of extract is obtained, to be 3s. 9d.; and on the supposition that a brewer's consumption of malt is 2000 quarters per annum, his yearly loss as relates to produce, will be found to be £375 per year; and surely it would pay him much better to give a good maltster high wages and obtain a full produce, than an inefficient maltster low wages, and obtain but a deficient produce. And should it not be possible to meet with a good one, or even if it should, would it not be better that the principal should seek and obtain that knowledge which would enable him to instruct an ignorant maltster, or appreciate the necessary qualifications to constitute a good one?

But a deficiency sustained in the produce of malt as relates to the numerical value is not the only injury experienced, inasmuch as a deficient produce may be said to be synonymous with an inferior produce; for the same cause which produces the one invariably produces the other; and the latter evil is not only an injurious addition to the former, but of more serious consequences, as good beer cannot be produced from bad malt, and if the stated loss is doubled or even trebled, no exaggerated statement would probably be made.

But many brewers gain and gain largely, by doing much business at a small profit, and are satisfied, because they do not enquire, and consequently do not know, how much more they might gain by the pursuance of a better system: and there are many who do much business and gain little or nothing, or lose much, and wonder what is the cause.

The injudicious choice of an incompetent maltster, or the inability to find a good one, is as the erection of a building upon a bad foundation.

A maltster whose ignorance of his business is the result of bad teaching, of prejudice, of an incapacity or indisposition to learn, is the last that will submit to be taught; and however desirous a brewer may be, that his maltster should endeavour to improve his system of malting, and however capable and willing he may be to instruct him, yet it is a hopeless task, for the greater his need of being taught, the more obdurate will be his determination not to learn; and it will be found far easier to instruct a blank and uncultured mind under the influence of a desire to learn, than to eradicate the weeds of prejudice and selfconceit from an ill cultured understanding, and to cause the production of a better system of malting.

The practice of malting is a traditionary process; it is an imitative system of labour, in which three of the five animal senses are engaged, seeing, feeling and smelling; and in which the mental faculties have usually but little participation.

An experienced practical maltster can tell when his corn is in good working order, when it needs turning or raking, more warmth, more air, or more water; an acceleration or retardation of the process, and when it is fit to go to the kiln and the various operations thereon, by the intuitive indication of one or all of these senses; but if you ask him to state the mode by which he judges, he is quite unable to express the means by any clear and definite language, because the mind has no participation in the determination; and as his experience is incommunicable in words, so it is in practice, for he cannot impart to another by any mental instruction, the discernment of the animal faculties, which he has himself acquired by long continued observation.

It may then be asked, how is a competent knowledge of malting acquired? And the reply to the question is this. A young man who cannot perhaps either read or write, engages to take a situation as under maltster, and all the qualifications required in him, to enable him satisfactorily to fulfil the duties of the situation, are tractability, industry, and an aptness to learn, in addition to those moral qualities which are requisite for all employments. It is his business to do what the head maltster tells him, who communicates no information or motives for his directions.

If the head maltster puts his hand in among the grain upon the working floor, and (therefrom deducing the motive for the act) tells his assistant either to rake or turn the corn, in which he perhaps assists himself, he does not explain to him the reason why he put his hand therein or the peculiar sensations which he experienced by so doing, that induced him to give the directions; and all the assistant can do to discover, is to put his hand in too, and to note the sensation which he experiences, and every time the command is repeated to do the same, until at length he acquires that intuitive knowledge which is derived from the communication of certain intelligence, which is conveyed from the peculiar condition of the grain to the sense of feeling. And this knowledge is incommunicable from one man to another, because he cannot describe in intelligible language the nature of the sensation which he experiences himself, or what his assistant should feel; consequently as the head maltster directs him to rake or turn, when a peculiar excitation of his sense of feeling is produced, so the assistant by experiencing the same sensation gradually becomes initiated by habit in the art of ascertaining the mode and the proper period for acting.

The sense of smelling is also employed to determine the proper time to open the windows for the admission of fresh air, and the expulsion of the deteriorated air and the carbonic acid gas: while the sight is employed to ascertain the proper period to increase or decrease the thickness of the grain upon the floor, to sprinkle and to supervise the whole process from the commencement to the end, and in assisting the other senses as they may occasionally need its aid; and in order to learn this comparatively instinctive system of malting, the assistant must do just what the head maltster does, and what he tells him to do, and draw his own conclusions, and inform his judgment by his own observations, and in proportion to the keenness of his animal faculties, and to the correctness of his deductions, will be his attainments in the art of malting.

That such is the general mode, by which the practical process of malting is learnt, and that few are the exceptions to such a rule, we trust will be unhesitatingly admitted; and that such will be its continuance, unless the system is rescued from the imputation, by the diffusion of more knowledge and the payment of higher wages, as an inducement to men of intelligence to engage in the operation, we have no doubt; and it is for brewers to consider, who are deeply interested in the obtainment of large extracts, and of the best quality from malt, whether or not the improvement of the system promises advantages, more than equal to the extra cost to effect it.

MASH, *to beat into a confused mass, to mix malt and water together in brewing.*

The purport of mashing in the brewery, is to blend intimately together, the malt and water in the mash tun, in order that the water may have access to every portion of the malt, to effect a solution of its soluble parts; and whether performed by oars, rakes, or machinery, it should be effectually and promptly accomplished.

Mash.

To administer the water at a correct temperature to dry malt, or in technical terms, to take a right first mashing heat, is of the first importance, as it may be said to be the first step in the process of brewing, and which, if improperly taken, the results are injurious to an amount, proportionate to the extent of the deviation from the heat which should have been taken.

No method can be more fallacious than that which is usually adopted to determine what should be the first mashing heat. The usual method is to masticate a small portion of the malt, and to infer from the color, the amount of heat which it may have received on the kiln, as if the reception ensured the retention. If heat was not fugitive, then indeed, means might be adopted to ascertain the amount imparted to malt on the kiln, and to deduce therefrom, what should be the first mashing beat; but as it is fugitive, and the temperature of malt is liable to a reduction to an indefinite extent, subsequent to drying and previous to brewing; it is therefore clearly evident, that the deduction should not be from what it may have received, but from what it may possess at the time of mashing. But on the supposition that the first mashing heat should be deduced from the amount of heat which the malt may have received on the kiln, or the intensity of the color imparted, it is most absurd to suppose that the eye can accurately or approximately determine either; and if it could, then where is the rule to govern the deduction? The fact is, that experience has taught, that the impartation of color to malt on the kiln, is proportionate to the quantity of heat imparted, under ordinary and usual circumstances; and that the more heat which has been imparted, the less is the amount of the heat of solution which is required in the menstruum used for the purpose of effecting it; or in more intelligible language, the more color which malt possesses, the lower should be the first mashing heat.

But this is a relative and not an absolute fact; for although the temperature of solution of pale, amber and brown malt, at the same thermometric heat differs,—that which having received the most heat on the kiln, requiring the least heat in the mashing menstruum, yet should the thermometric temperature of the brown malt at the time of brewing, be lower than the pale, it may be requisite that the temperature of the menstruum for the brown malt should be higher than for the pale.

Most of the treatises on brewing, furnish the indications, by which we may judge, whether or not a correct first mashing heat has been chosen, and from which we may derive the satisfaction of knowing that we have guessed right, or feel the mortification that we have done wrong; but they are quite silent as to the measures which should be pursued beforehand to discover the proper mashing heat, and by adopting it, ensure advantageous and avoid disastrous results.

But in my Practical Treatise on Malting and Brewing, I have disclosed the means by which it may be ascertained, and to save the practitioner from the labour of calculation, and the liability of error as well as a loss of time, I have furnished tables sufficiently extensive to cover all cases of common occurrence, and by many years' practical use of them, have verified their invariable and certain utility.

It may be the opinion of some, that the choice of an incorrect mashing heat, may be attended with no other disadvantageous results, than a deficiency in the amount of extract obtained; but such is not the fact, for not only is the deficiency in the quantity of extract obtained proportionate to the extent of the deviation from a right first mashing heat, but the quality of the extract is proportionably inferior.

Some brewers are sufficiently inconsistent as to imagine, that if an improper first mashing heat is chosen, it is a matter of little consequence, as long as the goods are not set, and the wort will run off, as they expect that the evil will be corrected by the subsequent mashings; but they have yet to learn, that if the first mashing heat is incorrectly taken, no subsequent measures that can be adopted, will remedy the evil which has been created; and that instead of a correct second mashing heat supplying the deficiency in quantity and quality of the extract obtained in the first wort, it will be of itself deficient in both, in consequence of the cause that produced the insufficiency in the first wort; and they will find that the first false step will place them in a path which diverges from a right line, instead of converging to it.

There are others who imagine, that if the wort will but run off the goods, then all must be right; and also others, a little more advanced in knowledge, who require that it should run off freely, to satisfy their minds that all is right. But both one class and the other, are or appear to be, entirely unacquainted with the facts, that every parcel of malt that is mashed, requires a correct heat of the menstruum, to dissolve in proper proportions, the several substances of which malt is composed, and that the heat of solution of those substances is not the same as relates to the limits of solubility. That the range in the temperature of solution of saccharum, is more extended than that of fecula, and much more extensive than that of gum and gluten. That there is a perfect temperature of solution for each, although such is neither definite or invariable. That such perfect temperature is of a compound amount, connected with and relating to the condition, properties, quantity and quality of the dissolving menstruum, and the temperature, condition, quantity and quality of the substance to be dissolved, and dependant also on the varying and peculiar circumstances under which such solution is effected.

As malt is a compound of substances, and a solution of each in relatively correct proportions is necessary to furnish a wort of the required quality, and as each of these substances possess a perfect temperature of solution separately, differing in amount; so is it necessary to choose such a temperature to dissolve them in conjunction, as will furnish a solution of each to a correct extent; and it should be the brewer's most anxious desire and unremitting endeavour, to obtain a sound theoretical knowledge of the subject, and the rule by which such compound temperature of solution may be discovered, and to deduce therefrom, the proper temperature for the mashing menstruum.

As the capability of converting grain into malt by well-defined, restricted, yet ample means, is a delegated power for specific purposes; so are the means of appropriating such malt to the purpose of manufacturing beer, or other purposes, also well defined, limited, and yet ample.

Thus in appropriating malt to the purpose of manufacturing beer, the means to accomplish such an object, is first to crush or grind it, then to add water to it of a suitable temperature; and the same beneficent being, who doeth all things well, appointed a perfect temperature of solution of the several substances of which such malt is composed, in order that their solution in relatively correct proportions may be effected; but he did not restrict the power to effect their solution in conjunction to a narrow, but on the contrary to an extensive range on either side of the perfect temperature of conjunctive solution, as if to admit of a latitude of error without inflicting total loss, but yet apportioning the amount of loss to the extent of deviation from the correct temperature of the mashing menstruum.

To administer the mashing menstruum to malt at a temperature beyond the limits of the temperature of conjunctive solution above or below, is, in technical language, to totally set the goods, so as not to be able to òbtain any wort from the malt, in consequence of rendering the malt and water an homogeneous compound; and such an effect is productive of total loss, as relates to the manufacture of beer. To administer it at a temperature just within the prescribed limits of the temperature of conjunctive solution, so as to be able to draw off a small quantity of wort, is in the same language, to partially set the goods; and the partial setting of the goods may be gradatory, involving loss proportionate to the extent of deviation from the perfect temperature of conjunctive solution; and which is evinced by those appearances and demonstrations, with which the experienced brewer is well acquainted.

MAWKISH, *a peculiar flavor that causes loathing.*

All the animal faculties of man are endued with that sensitive discrimination, which is sufficient to enable the discernment of that which is salutary and pleasurable, or insalubrious and unpleasant, without reference to the perceptive determinations of the mind; and this power or capability is called instinctive.

Thus, as illustrative of the theorem, and adapted to our purpose, the human palate loathes the taste of unfermented wort, and the term of expression used to denote the cause of such loathing, is its mawkish taste. And this loathing is instinctive and not mental, inasmuch as the discriminating powers of the mind are not employed in enquiring, reflecting, and determining whether unfermented wort is a proper aliment for the body; but the palate is gifted with, and employs that instinctive discernment, which enables it to pronounce it as unfit for consumption; and the mind receives the intelligence from the palate, by its expression of disgust, and the will is therefore instructed to reject it.

Nor are the instinctive powers of the palate limited to the discernment and rejection of wort that is totally unfermented, but that also which is partially and insufficiently fermented; and such a beer presented to the palate, is pronounced mawkish.

Different individuals differ in their opinion, as to the state and condition of beer, upon which the sentence of mawkish should be pronounced, because their palates naturally or by habitude vary in their discriminating power, and that which may be unpleasant to one, may be pleasing to another. But it may be objected to this doctrine, that the palate often allows food to pass into the stomach, from the flavor of which it derived much gratification, but which food does not afford a salutary support to the body; and it is true that there are many exceptions to the rule of that perfect agreement of the discriminating power of the palate, and a resulting loathing for that which is unfit for the reception of the stomach, but those exceptions do not invalidate the correctness of the rule. The palate may be naturally defective, or artificially disordered, or the stomach and the animal functions may be disorganised, diseased or temporarily deranged; and the same food which would be loathed when all the animal faculties are in a healthy state, may be approved by the palate, when its functions are in a deranged state; and that food which the palate would approve, and which would be wholesome and salutary, when the animal functions are in a healthy state, may prove unwholesome and injurious when they are in an unhealthy state.

Insufficient boiling of wort is another cause of mawkishness of flavor in fermented beer, owing to the insufficient abstraction of gluten from the wort, by coagulation; and such beer to the generality of consumers, is less wholesome than such as is sufficiently boiled, and more liable to an acetous fermentation.

MECHANICS, *the science or laws of motion.*

A knowledge of the science or laws of motion, should not only be possessed by every projector of the fitting up of a manufactory, but also by those who have to accomplish the work; as the facility, the economy, and the profitable operations of manufacture, so materially depend on the correctness of principle on which the machinery is fitted up.

Nor should the manufacturer himself be destitute of this knowledge, or be deficient in a comprehensive and extensive knowledge of the rudimental and practical principles of the science of mechanics, as well as of all other sciences which have a direct or remote connexion with the branch of manufacture in which he is engaged, as such knowledge will be frequently required to enable him to correct and improve the practical details of the process of manufacture, and prevent many serious losses, and the injudicious outlay of capital which may be prompted by the otherwise erroneous views of himself or others, or the cupidity of those who endeavour to induce an injurious expenditure and a source of profit to themselves.

A knowledge of the science of mechanics alone, is not sufficient for the interests of the manufacturer; and the possession of such only, may cause an illustration of the truism, that "a little knowledge is a dangerous thing," inasmuch as it may induce the construction and appropriation of machinery, which may furnish mechanical advantages, but produce chemical injuries.

As the processes of malting and brewing are chemical operations as well as mechanical, it is quite desirable, if not absolutely necessary, that both the maltster and the brewer should well understand the principles, and much of the practical details of the sciences of chemistry and mechanics, in order that they may not allow the results of the operation of one, to come into collision with the requirements of the other; and to an acquaintance with such branches, they should superadd the knowledge of pneumatics, hydrostatics, hydraulics, &c.

Abstractedly considered, the laws of motion are affinity and attraction, as subsisting between the several species or classes of ponderable atoms of which all bodies are composed, inducing them to quit their positions in order to unite together, and enabling them so to do when brought into the sphere of mutual attraction; and by the law and power of equal diffusion which governs the imponderable atoms, which are intimately intermixed with the ponderable atoms by the law of constituency; and by the influence and operation of which law, motion is imparted both to the imponderable and ponderable atoms.

But the term mechanics, is applicable to the law of motion which governs substances, agreeable to the generally received opinion, such as gravity, levity, &c. yet as the terms gravity and levity applied to substances, are synonymous with the terms attraction, equal diffusion and recession, applied to atoms; so the knowledge of the latter is the true basis for a competent knowledge of the former.

The term gravity implies nothing more than the aggregate attraction subsisting between all the ponderable atoms of which a body is composed, and the whole of the atoms of which the earth is composed, inducing a tendency in such body to fall toward the earth; and levity nothing more than the exertion of the power of recession to an aggregate amount, proportionate to the number of imponderable atoms commixed with the ponderable atoms of which a body is composed, inducing such body to recede from the earth.

Thus the terms, ponderable and imponderable atoms, affinity, attraction, equal diffusion and recession, express the basis on which all the sciences are reared.

The science of mechanics then properly considered, is but one of those streamlets issuing from the sole source, or fountain head, which contributes to the fertilization of every field of enterprise, and distributes social benefits and national advantages in every direction in which it flows.

MELLOW, *to soften, grow soft, ripen, mature.*

All grain that is not well ripened in the field previous to its being reaped, or is in an immature state at the time of steeping, cannot be in an advantageous condition for the process of malting. But grain may be well ripened in the field, yet owing to the qualities of the species sown, or the unsuitable state of the soil in which it is deposited, or to its being subject to casualties during the period of its germination or vegetation, it may not be in good condition for the purpose of malting.

One of the technical terms which is used to denote the quality of grain which is in a good state for malting, is, that it is mellow; and another technical term to denote the quality of that which is unfit is, that it is steely.

The appearance of mellow grain when cut asunder is white and of a chalk-like texture, and implies the presence of much fecula: and the appearance of steely grain when cut, is of the color and texture of horn, and implies the presence of much gluten.

Grain in the latter condition when cut, may be improved by what is called sweating in the mow, or on the kiln; and when of necessity it is submitted to the process of malting, a peculiar and suitable system should be adopted, to convert it into malt of a middling or good quality.

The term mellow is also used, to denote the condition of grain in the process of malting, when it has proceeded favorably, and has arrived at that state of maturity, as is indicative of its fitness to be thrown on the kiln, for the purpose of terminating the progress of germination, for the impartation of color and flavor, and the expulsion of all moisture. When grain in such condition is crushed, the internal substance is found to be white, pulverulent and farinaceous.

The same term is also used to express the favorable condition of dried malt, which is well manufactured, and is crushed with facility, and which exhibits the general appearances of maturity, both in malted and unmalted grain.

MENSTRUUM, *a dissolvent.*

The dissolution of a body, whether solid, fluid or gaseous, is effected either by overpowering the attraction of cohesion, or the attraction of aggregation, pre-existing among the atoms of which it is composed; and to accomplish such purpose, either atoms of heat must be imparted to such body in sufficient quantity, as is necessary to forcibly separate the ponderable atoms from each other, to such a distance as will place them beyond the sphere of attraction in which they were before situated; or by immersing such body in a fluid or gaseous body, or placing it in contact or proximity with some solid body, constituted of such species of atoms, and so arranged and situated, as that the attraction between the atoms composing the dissolving body, and the body to be dissolved, is greater than the attraction of cohesion or aggregation, subsisting between the atoms of which the body subject to dissolution is composed.

To dissolve a body by the impartation of heat only, the immersion of the body to be dissolved in a liquid or gaseous fluid, or the placing it in contact or proximity with a solid body, possessing more heat than the body to be dissolved, and sufficient to effect its decomposition must be performed; and by the law of equal diffusion which governs the atoms of heat, a sufficient quantity will quit the dissolving body, and enter into the body to be dissolved, as to render the amount of heat in each equal.

To dissolve a body by the power of affinity and attraction, it is necessary that the body to be dissolved should be immersed in the gaseous or liquid fluid, or placed in contact or proximity with the solid body which is able to act upon it as a dissolvent; and the decomposition of such body, will be effected by the power of affinity subsisting between the classes of atoms of which the menstruum is composed; and the result of such affinity will be the disunion of the atoms composing the bodies separately, and their reunion agreeable to the influence of affinity, effected by the power of mutual attraction, and a new body will be formed from the atoms of the two bodies, characterised by different properties than were either of the bodies separately.

A menstruum which is able to dissolve a body of definite weight or dimensions without the aid of heat, is able to effect the dissolution of a body of greater weight or dimensions by the aid of heat. Thus the soluble substances of malt may be partially dissolved by cold water, but a much larger portion may be dissolved by warm or hot water, and a most important part of the process of extraction, consists in apportioning the right quantity of heat to the menstruum, previous to its access to the malt.

As malt is composed of four substances, saccharum, fecula, gum and gluten, and each of these substances require a different temperature of the menstruum, to effect a solution of all the soluble portions of each substance, so is it necessary to choose a proper mean temperature of the menstruum first applied, as is sufficient to dissolve a proper proportion of each; and knowledge, judgment and care, is not only requisite to determine on that heat which will effect such purpose, but also that such a temperature may not be chosen, as will inseparably blend those four substances, instead of dissolving a portion of each, and causing such as is dissolved, to be transfused throughout the dissolving menstruum. The technical term for such an inseparable blending is, "setting the goods."

To dissolve the whole of the soluble portion of the substances of which the interior of malt is composed, the administration of several repeated quantities of the menstruum is necessary, as no single quantity however great, at whatever heat, or however long the continuance of the infusion, is sufficient to effect the solution.

Much difference of opinion exists as to what should be the temperature of the second and subsequent portions of the menstruum, and the way in which they should be administered; but there is a correct heat and method, and that it is the interest of every brewer to endeavour to discover it, is indisputable.

The quality of water as a menstruum for the solution of malt, the solution of the several substances in relatively correct proportions, the solution of the whole that is soluble at a proper temperature, the proper fermentation of the resulting wort, the flavor of the produce, its ultimate freedom from acidity and putridity, and its perfect transparency at the period of consumption, are all points of primary consideration in conducting the process of brewing, and the production of a beverage that is calculated to prove satisfactory to the public.

Spring water, however pure and translucent in appearance, may be impregnated with acid, minerals, &c. and may need chemical purification previous to its use as a menstruum.

Pond or river water may be superior to spring water, as relates to the absence of acid, and dissolved minerals, but inferior as relates to a variety of impurities which may be both simply and chemically combined with it; and although filtration may free it from those impurities which are in a state of simple mixture with it, yet additional means are requisite to abstract those impurities which are chemically combined with it.

If return wort is used as a menstruum for malt, its temperature for the first application should differ from that of water.

NARCOTIC, *stupifying, opiate, causing sleep.*

The result of vinous fermentation, is the production of two narcotic substances, spirit and carbonic acid gas; and an estimate of the value of vinous fluids, is by many founded on the abundance of those substances which they contain; and their effect in producing stupefaction, is the standard by which the quality of the fluid is determined. The primary purport of vinous fluids, is to exhilarate the animal spirits, and recruit the muscular strength, by an impartation of a portion of the product of its decomposition in the stomach, to the nervous fluid which circulates throughout the whole of the animal system; and if more is drank than is sufficient for such purpose, the spirituous and gaseous product in excess, ascends by distillation and fermentation to the brain, and causes stupefaction in proportion to its amount, and the organic structure, state and condition of the brain, and the excess, and not the sufficiency, becomes injurious to the health.

The quantity of nutriment required by the nervous fluid, is proportionate to the muscular exertion; and as the exhaustion of such fluid by manual labour or bodily exercise is considerable, so should the amount, the frequency, and period of the supply of nutriment be proportionate to the amount, the circumstances, and the occasion of its exhaustion.

The nutriment required by the nervous fluid, is obtained from solid as well as from liquid food, but with more promptitude from the latter than the former, and hence its greater suitability to afford an immediate supply for a rapid and extraordinary demand; and the exhausted labourer finds more relief from fermented liquids than solids.

The relief to the animal system is more rapid from spirits or spirits and water, but not so permanent as is derived from the consumption of beer, as a prompt distillation of spirit occurs, when raised to the temperature of the stomach, and is lost before the product can be imparted to the nervous fluid; but as beer experiences a chemical decomposition in the stomach, and the temperature at which the distillation of spirit diffused throughout its mass occurs, is much higher than occurs to such as is mixed with water, the performance of the process occupies a longer period, and consequently more time is furnished for its impartation to the nervous fluid; and as in the process of the decomposition of beer in the stomach, a portion of spirit is generated, both the production and distillation occupy a long period, and the delay enables the gradual and continual impartation of the spirit to the nervous fluid.

The decomposition of beer in the stomach, will furnish much more heat, and nutriment to the animal system than spirit: in fact, the decomposition of spirit in the stomach causes an abstraction of heat from the system instead of an impartation, so far as relates to its decomposition; for being converted into vapour by the impartation of heat to it from the system, its separation from the water with which it was mixed occurs, and by such a conversion, it abstracts a considerable quantity of heat from the system; and although a portion of heat which was abstracted from the system to convert the spirit from a liquid to a vapour, may be imparted by the power of equal diffusion to such parts of the animal system through which it passes in its progress as a vapour, yet is the loss of heat from other parts consequent on its conversion, greater than the quantity which is evolved from it in its progress as a vapour, and the consumption of spirit is, literally, the robbing one part of the animal system of its heat, in order to impart an extraordinary, yet evanescent supply of heat to another.

But in the consumption of beer the case is somewhat different, for although the same proportionate abstraction of heat from the system, is necessary to convert the spirit which is diffused throughout it into a vapour, and the same proportionate loss to the system must occur, yet as beer is composed of spirit, water, and a large quantity of malt extract, and a decomposition of such extract must be effected in the stomach, so therefore must the constituent latent heat of such extract, be imparted to the animal system upon the decomposition of such extract; and if the amount thus imparted, is greater than the amount lost by the conversion of its spirit from a liquid to a vapour, then will the balance be in favor of the impartation of heat to the animal system by the consumption of beer; and it must therefore be obvious, that the more unfermented or undecomposed extract of malt which beer possesses at the time of its consumption, the more heat will be imparted to the animal system by its decomposition. And it is this instinctive consciousness that beer imparts more heat to the system than spirit, which induces the prudent labourer to prefer the consumption of the former to the latter, for the purpose as he terms it, "to work upon," and why he prefers a beer moderately fermented to such as is attenuated to a great extent, is because he finds that labour induces perspiration, and that perspiration causes to the system a loss of heat and nervous fluid, (alias strength) and that as the loss of such heat and nervous fluid, causes the sensation of pain, exhaustion, and weakness, without a continual supply of heat and nervous fluid to the system, proportionate to the amount of consumption of both, so he instinctively prefers to consume such liquid and solid food, as will most promptly and effectually furnish the supply in the ratio of the demand; and hence the preference to beer above spirit, and beer with plenty of malt extract in it unfermented, for the purpose of affording sustenance to the animal system, subjected to the exhaustion resulting from labour.

The erroneous system of estimating the quality of beer by its intoxicating capabilities, has induced the use of narcotic drugs, as a substitute for a considerable portion of malt, the brewer endeavouring to comply with the vicious desire to effect stupefaction at a small expense, and obtain a reputation for beer apparently of good quality at a small cost.

As the legitimate purport of consuming fermented liquors, is to furnish strength and heat to the animal system, and to afford a supply of nutriment proportionate to the amount of exhaustion, all that is consumed beyond what is sufficient for such a purpose, is injurious both to the stomach, the intestines and the brain; and as narcotic drugs do not impart the benefit which is sought, but confer all the evil which should be avoided, their introduction into beer is not only useless, but positively highly injurious.

NITROGEN, *a species or class of atoms, which forms a constituent portion of many substances or bodies.*

We are deeply indebted to many eminent men, whose researches in the various departments of science, have led to the discovery, that all bodies whether solid, fluid or gaseous, are compounded of atoms of distinct species, and to their labours in the department of chemical analysis, for the proportions of the several species of atoms of which many bodies are composed.

The denominative term to designate one of the species or classes into which the atoms composing bodies are divisible, is nitrogen, and such species or class of atoms is found to enter largely into the composition of some bodies, and in small proportion in others. The abundant proportion of it in nitre, has induced the derivation of its appellation.

As a component of pure atmospheric air, it forms about 72 parts in 100, the residue being about 28 parts of oxygen; and constitutes that portion which neither supports combustion nor animal life; and in respiration is ejected from the lungs, being separated from the oxygen therein, and the oxygen being imparted to the blood by transference through the membraneous vessels which extend in ramification throughout the substance of the lungs.

It may be considered as an ally to oxygen, and forming together a salutary compound, when either in a separate state would prove destructive to animal or vegetable life.

As nitrogen gas is incombustible, it may be procured from atmospheric air, by abstracting its oxygen by combustion.

Without an admixture of oxygen gas, nitrogen gas is immediately destructive of life.

The atoms of nitrogen and oxygen unite by the power of affinity and attraction, induced by defined and limited laws.

In respiration, the atmospheric air which is inhaled, is decomposed in the lungs, its oxygen is imparted to the blood, furnishing it with its crimson color, and the principle of life to the animal system; and the nitrogen is ejected from the lungs, and which being lighter than atmospheric air, ascends therein. The short pause which occurs between respiration and inspiration allows the respired nitrogen to ascend sufficiently high in the atmosphere, before the act of inspiration commences, so as to prevent the liability of the re-entrance of the respirated nitrogen gas into the lungs; and as in the decomposition of all substances, their constituent and latent heat is rendered active, and the heat thus liberated is imparted to other bodies in proximity, so in the decomposition of air within the lungs a considerable portion of its heat, and all the constituent portion appertaining to the oxygen of which it is composed, is imparted to the blood in conjunction with the oxygen; and thus it will be perceived, that by this admirable and consummate chemical and mechanical arrangement, the principle of life and heat is imparted to the animal system, from that abundant and inexhaustible source—the atmosphere.

The purport of the impartation of oxygen to the blood, is the union of it with the carbon of the blood, for the purpose of forming carbonic acid; and the impartation of heat to the blood, is for the purpose of causing its motion, and to render it of such a tenuity, as will enable it to circulate through the smallest arteries: and also for the purpose of converting the carbonic acid into gas; and the conversion of the latter into gas, is for the purpose of rendering it transmissible throughout the whole of the animal system, as its sustenance and support by atomic accretion; and finally for the exudation of such as is superfluous for the purpose of accretion through the innumerable pores of the skin. From this exposition it is apparent, that to breathe a pure air is more wholesome and healthy, than an atmosphere which is vitiated either by the admixture of extraneous gases or substances, or from the abstraction of its oxygen; and in crowded or insufficiently ventilated apartments, when the exit of the respired air and the ingress of pure air, is not in the ratio of the respiration and inspiration of their inmates, then is the health affected in proportion to the amount of the difference, or to the constitutional powers of those who inhale the vitiated air, or to the situation and circumstances under which each individual may be placed.

The atmosphere of an apartment wherein the combustion of any inflammable substance occurs, is vitiated by the abstraction of oxygen therefrom to support it, and it may also be vitiated by the products of such combustion being mixed with it; and in crowded or inadequately ventilated rooms, which are illuminated by any substance in a state of ignition, the atmosphere becomes vitiated to a much greater extent, and should the supply of air be equal to the demand resulting from the abstraction of oxygen, and the change of its specific gravity by the addition of heat, and its consequent exit from the room, then are the inmates subject to the chilling and injurious effects of the passage of a current of air passing over the surface of their bodies which rushes impetuously in through every lower crevice which the room presents, to occupy the place of such air as may have departed through the upper orifices which may have been purposely or accidentally provided for its escape.

Nitrogen forms a component part of malt, hops, yeast, &c. and is a necessary, although not a prominent principle in fermentation; and appears to be useful in neutralizing a considerable portion of oxygen, which otherwise might prove injurious, and thus to render it an innoxious resident, yet ready for any required purpose, which a subsequent operation to which the substance may be subjected, may induce.

ODOUR, *a scent, smell, fragrance.*

Cleanliness in manufactories, as well as in domestic residences, is a most important point of consideration, and a subject that needs the best attention, particularly in such manufactories, the produce of which must be submitted both to the smell and the taste, previous to and during consumption; and the absence of a nauseous, and the presence of a pleasant odour, enhances the value of all edible and drinkable commodities, to an amount which is more than commensurate to the cost and labour of cleanliness.

The odour of all the ingredients used in brewing, when of good quality, is both fragrant and pleasant, and the rich perfume rising from boiling wort, is wafted in grateful fragrance to the olfactory nerves of many a well pleased recipient; but the communication of an ill scent and flavor, is too frequently imparted in the subsequent stages of the process of brewing, &c. and is at all times the result of bad arrangement, carelessness or wilful neglect.

Putrefactive fermentation is the general source, from which an ill scent and flavor is derived by wort or beer, in its progress from the copper to the cask of consumption; and the cause often lies in the improper construction, situation and arrangement of the several utensils through which the wort has to pass, from an inability to cleanse them properly after each brewing, or from neglect in doing that which might be done, and by not occasionally resorting to those chemical and mechanical measures to prevent its occurrence, to which there always is a liability, even with the utmost attention to cleanliness.

For this purpose, a disinfecting fluid as a preventive and curative is requisite for general use, of small cost, and of effective capability; and the many years' experience which we have had of the efficacy of such a fluid without any failure, when of sufficient strength and properly used, as a preventive to and curative of putridity, whether such as is technically termed the fox, or must, and also for the purpose of abstracting acid from casks or other utensils, and tanin from new wood or old wood fresh cut, (which imparts what is termed a wood flavor to liquids) justifies our strong recommendation of its use to every manufacturer, who makes use of wood utensils for the manufacture or preservation of any beverage.

A putrid fermentation experienced in the brewery, generally occurs, either from the abstraction of a putrid ferment from the surface or pores of one of the utensils used, such as the mash tun, under back, jack back, hop back, cooling backs, refrigerator, fermenting tuns, cleansing casks, stillions, sending out casks, pumps, pipes, &c. or the administration of putrid yeast as a ferment to the wort in the fermenting tun; and it should be remembered that yeast is ever prone to such a species of fermentation, and that it often occurs to an imperceptible, as well as a considerable extent. Wort left in a state of adhesion to any utensil, whether of metal or of wood, is liable to a putrid fermentation, particularly in hot weather; and all wood, but particularly such as is decayed, soft and porous, is capable of absorbing and retaining wort, which if not well washed out with clean water promptly after use, the dry extract of malt, which is left in a state of adhesion or absorption, is subject to a putrefactive fermentation, induced by the access of air of a high temperature.

When such vessels are, or must be used, there needs as a preventive to, or curative of putrefaction, a chemical disinfecting fluid, that will penetrate to the situation to which such extract has gained access, and acting upon it as a dissolvent, such extract is abstracted either previous or subsequent to the occurrence of the putrefactive fermentation.

OXYGEN, ***a species or class of atoms, forming a constituent portion of bodies or substances.***

The species of atoms denominated oxygen, is not known to exist in an uncombined state with other species, but is found to be a constituent in conjunction and intermixture with other species in various proportions, in most, if not in all bodies. Its known purest and uncombined state, is as oxygen gas.

Oxygen combines with all metals by accretion as a non-constituent, except gold and silver with the aid of caloric; but some metals require the aid of a very considerable quantity of caloric to effect the combination.

What is commonly called rust, is oxygen combined with iron, and the resulting compound is by chemists termed an oxide of iron. An acid is the medium of union between oxygen and gold and silver. Verdigris is a compound of oxygen and copper. Red lead is a compound of oxygen and lead.

Oxygen gas is generally obtained from red lead, or black oxide of manganese, with the aid of sulphuric acid or heat, as they possess an abundance of oxygen, are of moderate cost, and the obtainment therefrom is easy.

Oxygen gas forms 28 parts in 100 of atmospheric air, the remainder being nitrogen or azotic gas.

Without the presence of oxygen combustion cannot be supported; the addition of oxygen to the combustible body being indispensably necessary to support and continue the combustion of the body, and the usual source of the supply of oxygen for the purpose is the atmosphere.

Oxygen and hydrogen united form water, sulphur and oxygen sulphuric acid

Oxygen is the chief principle of acidity; its presence is absolutely necessary to constitute an acid, and in proportion to its quantity as a component part of a body, so is the intensity of the acidity of that body.

The usual and general sources of the supply of oxygen to bodies naturally are air and water, and the facility and cheapness of the supply from such sources, render those elements in that as well as in numerous other respects, most conducive to the welfare of all things animate and inanimate.

Oxygen is the principle, as a constituent of atmospheric air, which supports life, and imparts a crimson colour to blood; and the nitrogen which forms the principal constituent portion of air as relates to quantity is destructive of life.

Oxygen gas pure and unmixed with nitrogen, would also prove destructive, by its powerfully stimulating effects upon the human frame; and such powers are therefore both wisely and beneficently diminished, by the neutralizing effects resulting from the combination of nitrogen therewith, in the composition of atmospheric air.

Oxygen imparted to fermentable fluids, unites with the constituent carbon of such fluids, and therewith forms carbonic acid; and it also unites with a definite proportion of the constituent carbon and hydrogen of such fluids, and therewith forms spirit.

The source of the usual supply of oxygen to fermentable fluids is the atmosphere, both such as is simply and chemically combined with it; and the facility of impartation is aided by a definite and moderate quantity of caloric, co-operating with the power of affinity and attraction, subsisting between the oxygen of the atmosphere and the carbon of the wort.

At a low temperature of the fermentable fluid and the surrounding atmosphere, although the power of affinity subsisting between the oxygen of the atmosphere and the carbon and hydrogen of the fluid is the same as when both are at a medium temperature, yet not so the power of attraction, which is proportionate in intensity to the square of distance between the several species of atoms from each other; and as the impartation of caloric to the atmosphere and the fluid causes the expansion of both, and as the effect of expansion is the separation of the ponderable atoms of which a body is composed, farther from each other, and the effect of such separation is a diminution of the power of attraction of aggregation by which such ponderable atoms are held in proximity to each other, so therefore the higher the temperature of the fluid and the atmosphere, the greater must be the recession of the ponderable atoms of which each is composed from their associate atoms, and the nearer must be the approach of the ponderable atoms of each body to the constituent atoms of each; and thus the impartation of caloric to both bodies, causes a diminution of the power of attraction of aggregation subsisting between the constituent ponderable atoms of each, and increases the power of attraction of aggregation subsisting between the oxygen of the atmosphere and the carbon and hydrogen of the fermentable fluid.

The creation of carbonic acid in fermentable fluids by the union of the oxygen of the atmosphere with the carbon of the fluid, is for the purpose of abstracting such carbon from the fluid by the conversion of such acid into gas, and which conversion is effected by the union of the caloric rendered free and active by the decomposition of the fluid with the carbonic acid, and by its subsequent evolation from the fluid, in consequence of its specific gravity being less than the circumambient atmosphere; and this abstraction of carbon causes a diminution in the specific gravity or statical weight of the fluid, proportionate to the amount of the carbon abstracted; and the extent of diminution in weight, is limited only to the extent to which such abstraction can be continued; and when such limits are attained, as the impartation of oxygen to the fluid may still continue; so therefore will the weight or specific gravity of the fluid increase in amount, in proportion to the quantity of oxygen which may unite with the residue of its constituent atoms.

Those substances which become acid by the impartation of oxygen thereto, have peculiar bases called acidifiable, or salifiable.

Oxygen unites with the acidifiable and salifiable bases progressively, and to an indefinite and varied extent, and the resulting compounds are denominated acetous or acetic acid, the former denoting the presence of a moderate quantity, and the latter a large quantity of acid.

A vinous fermentation cannot be effected without the aid of oxygen, yet the presence of too much is productive of either a vino-acetous or an acetous fermentation.

The presence of oxygen in a state of simple mixture with the atmosphere is most abundant, as a general rule, when and where vegetative plants, &c. are in the greatest abundance, and when they are in the most vigorous state of growth, and hence during the spring and summer months, the vino-acetous, or the acetous fermentation, is more likely to occur than in autumn or winter; and fermentable fluids exposed to an atmosphere containing much oxygen in a state of simple mixture, either previous to its arrival, or during its continuance in the fermenting tun and cleansing casks, or subsequent thereto, is extremely liable to the conjunctive or the acetous fermentation.

Caloric powerfully assists the transpiration of oxygen from vegetables, and hence in sultry weather the atmosphere becomes charged with it in excess; and therefore if fermentable fluids are exposed to such an atmosphere in any of its progressive stages previous to consumption, it is subject to an impartation of oxygen from the atmosphere to a greater extent than the vinous fermentation requires, and consequently either the vino-acetous, or the acetous fermentation occurs.

Wort in the mash tun, the under back, the hop back, and the cooling back, is liable to the reception of oxygen to an injurious extent, and in such stages, the basis of a vino-acetous or an acetous fermentation is too frequently laid, either unavoidably, or in consequence of the ignorance or carelessness of the brewer; and although the present public taste, want of capital or room, or general convenience, compels the brewer to brew at an inauspicious period of the year, he needs but the requisite knowledge, and the possession of the suitable apparatus, with the exercise of proper care, to enable him much to mitigate, if not totally to avoid the evils incident to such period and the various resulting circumstances.

Nor is wort which may have reached the fermenting tun in a state of safety, as relates to the absorption of oxygen in proper quantity for the commencement of a favorable vinous fermentation free from the liability of a subsequent absorption of too much oxygen; and too much knowledge, skill, and care cannot be applied to the system of brewing throughout the various stages of the process, to prevent the accession of an improper quantity.

It is much too common and prevalent a practice, to remain apathetically content to endure a variety of manufacturing evils under the idea that they are unavoidable, instead of making the necessary enquiry, whether or not they can be alleviated or altogether avoided, by a deviation from the accustomed line of procedure in practice.

Indolence and prejudice are the chief barriers to research, and parsimony to the obtainment of the fruits of other men's labours; and those who are under the influence of these benumbing mental opiates, are little aware of the amount of their annual losses, and how small a portion of energy and exertion or pecuniary expenditure, in proportion to the value of the information which may be obtained, is sufficient for the removal of those evils to which they are subject, and the obtainment of more ease, clearer views and increased profits.

PELLUCID, *transparent, clear, bright, pure.*

The opacity of fluids and solids results either from their impenetrability to the passage of light, or from the rays of light being refracted by some of the constituent portions which are intimately blended with, and diffused throughout the body.

The opacity of fluids often results from the admixture of an opaque substance with a transparent fluid in a state of simple mixture; and the depuration of such adventitious substance, or its separation by filtration from the fluid, is sufficient to restore it from its state of opacity, to a state of transparency. Thus river, pond, and other water, is often rendered opaque by an admixture of a variety of adventitious substances therewith in a state of simple mixture, effected by agitation, &c. and if the specific gravity of such substances is greater than the water, its quiescence for a short period will be sufficient for the depuration of such substances, and by their subsidence, the water will be restored to its original transparency: but should the specific gravity of such or any part of such substances be less than the water, they will remain suspended and intimately diffused throughout it, and in such case filtration is requisite to free it from the impurities.

The opacity of fluids often results from the admixture of one or more opaque substances with the transparent fluid in a state of chemical combination, and such substances cannot be separated from the original fluid either by depuration or filtration, and by such an admixture a new compound is created; and to separate such substances from such fluid and restore it to its original purity and transparency, its precipitation or abstraction must be effected by some chemical agent or operation. Thus water may be rendered opaque by the admixture therewith, and the solution of a variety of substances, which cannot be separated therefrom but by some chemical process.

Many substances may be chemically combined with a transparent fluid which do not render it opaque, and chemical means are alone sufficient to separate them from such fluid and restore it to its original state. Thus water may dissolve a variety of substances which are mixed with it, without their causing its opacity, and various chemical methods may be necessary to separate and restore the fluid to its original state.

All river, spring, and rain water, whether opaque or transparent, contains adventitious substances in a state of simple or chemical mixture, which are more or less injurious or beneficial to a manufacturer, as the peculiar properties of the component fluid, affect the process of manufacture in which it is used.

Pure water, or approximating to a state of purity, may be obtained by distillation, and in such branches of manufacture as require water in a state of purity, will admit of the cost of its obtainment, and large quantities are not needed, it is usual to free it from its impurity by such method: but there are many manufactories in which a large quantity of water is required as a menstruum, and the presence of a variety of adventitious substances in such as forms their usual supply, may prove highly injurious to the manufacturer, by the impartation of disadvantageous properties to the product of solution, or by the prevention of solution to the full and most profitable extent.

To select the brewer as one of those manufacturers who are liable to be affected in the quantity and quality of the product of solution, by the use of water with which a variety of substances may be chemically combined, may be appropriate and serve to exemplify the liability of many other classes of manufacturers. He may be compelled to use river or pond water with which a variety of substances may be simply mixed, and by depuration or filtration he may render such water perfectly transparent, but still it may hold in solution and chemical combination, substances which may prove adverse to a favorable solution of the soluble portions of his malt, or if not so, it may contain such substances that may injuriously retard or accelerate the vinous fermentation, or promote an acetous or a putrefactive fermentation; or he may be under the necessity of using spring water perfectly pellucid, yet holding in chemical solution a variety of substances, that may prove equally adverse to the favorable solution of his malt, and the subsequent fermentation of its products.

One of the important enquiries which should be made previous to the erection of a brewery or other manufactory is, whether a sufficient quantity of good water can be obtained, and if the quality is not good, what are the substances combined with it, and can they be separated by depuration, filtration, and precipitation or abstraction, with sufficient ease and economy as to suit the purposes of common practice.

PERCOLATION, *the act of straining, or the passage of a fluid through a porous solid.*

The porosity of many solids, results from the peculiar arrangement of the atoms of which such bodies are composed during their formation or growth, thus wood is porous in consequence of the numerous channels or veins formed by the circulating sap during the growth of a tree, the component parts of which tree, consisting during growth of solid and fluid substances, the increase of the solid substance, resulting from the accretion of atoms thereto, imparted by the circulating fluid; and when the vitality of such tree ceases the fluid sap no longer circulates, the channels or veins through which it ran are soon empty, and some fluids will percolate through such veins or channels, when put into vessels formed of such wood.

The greater the specific gravity of the wood, the less is its porosity, because the channels or veins which conveyed the circulating sap throughout the tree during its growth, were less numerous or of smaller dimensions, or they remain more or less filled with dry sap. Such species of wood as are of the greatest specific gravity, are composed of more ponderable atoms than such species as are lighter, and are more impervious to the passage of fluids under any circumstances.

All fluids are subject to a diminution in quantity and an alteration in quality that are put into wooden vessels, however close the aperture of insertion may be secured, provided they are continued therein for any lengthened period, and particularly such fluids as are fermentable.

If a cask is perfectly sound, and there is not the least appearance of leakage, yet will the quantity of fluid within slowly and gradually diminish; such fluids as are not fermentable by evaporation, and such fluids as are fermentable by evaporation and the evolation of gas generated during fermentation.

Fill a dry cask with liquid, and in a few hours it will be found that it is not full, the wood of which the cask is formed having absorbed a portion. Fill it again and in a short period it will be discovered that it is not full, the first portion of fluid that was absorbed having penetrated deeper into the wood and having made room for the second portion; and if such process is continued, it will be found that the deficiency in quantity, is more than equal to the quantity that would be required to fill all the sap channels or veins contained in the wood, and it is therefore evident, that the further loss arises from the slow and gradual exudation of a portion from the external surface of the cask, which is swept off by the atmosphere as fast as it exudes, leaving no appearance of its presence or its escape, and the progressive diminution of the quantity in the interior, is proportionate to the loss from the exterior.

It is true that gas may be generated by fermentation much faster in the cask, than is sufficient to enable it to make its escape through the pores of the wood, but still an escape by such means does occur, although not sufficiently rapid to prevent the liability of bursting the cask.

Many fluids would percolate through earthenware, but for the glazed coating which fills up the pores of the internal surface; but such a covering is not sufficient to prevent the percolation of some fluids, which fast displace the glaze, and then permeate the baked clay of which the vessel is formed.

Glass vessels are not permeable by fluids, and are preferable to all other for the preservation of fluids; and if their orifices are stopped with well ground glass stoppers, or they are hermetically sealed, little if any loss in quantity can occur; but glass being pervious to light and heat, the properties of the enclosed fluids may be changed by the operation of such elements.

Corks inserted in the orifices of glass bottles, are not impervious to the carbonic acid gas, which is generated in the fermentation of fermentable fluids therein; and it will find egress with a celerity, proportionate to the soundness and the compression of the cork inserted. It is true that carbonic acid gas may be generated much faster than can escape by the cork, yet still the cork is permeable.

PERISH, *to die, to decay, to be destroyed or lost.*

Birth, growth, decay, death, and resuscitation, are the cardinal peculiarities of that endless circle, which encompasses all things animate and inanimate.

Accretion is the principle of growth, and abstraction the principle of decay.

The powers of accretion are limited, and the powers of abstraction illimitable.

Natural accretion is atomic, induced by affinity, and accomplished by attraction.

The power of affinity and attraction subsisting between the nucleous atom of a body and its connecting atoms, is more intense than such as subsists between the nucleous atom, and each succeeding atom which unites; and this first step in the diminution of attraction is succeeded by a second diminution, on the union of a third layer of atoms, and so continues progressively decreasing, until the influence of the nucleous atom, ceases to act on yet surrounding atoms, and this loss of power is due to aggregate or mutual attraction.

It is not to be inferred from this statement, that the power of affinity and attraction among the same class of atoms differs; and that in the formation of a body, the nucleous atoms possess a greater power than each succeeding atom; and that the accretion of atoms is in the ratio of the power possessed by each; and that by such a system of accretion, its limits extend to the termination of attracting power in the last uniting atom. But such limits are to be attributed to the limits of the power of aggregate or mutual attraction, and the mind will be assisted in the comprehension of this subject, by first considering, that the sphere of mutual attraction is limited; or in other words, the desire (called affinity) which two atoms may have to unite to each other, however intense it may be, yet if they are placed at a certain distance from each other and free to move, they cannot be drawn together, because they are situated beyond the influence of mutual attraction; but if situated within the limited distance assigned to such influence they will unite. And let us imagine two atoms, thus united, and a third floating within the sphere of influence of the two united atoms; and it must be obvious upon reflection, that as the power of attraction is limited, so such power divided between two atoms, cannot exert an influence upon a third equal to that which united the two; and a further division of such power among three atoms, must diminish the influence upon a fourth; and such diminution continuing, there must eventually be a termination to the influence: and it is such a termination, that proves the limits to the natural accretion of atoms, and the consequent increase of the magnitude of the bodies by natural accretion.

A body or substance which has attained to the limits of growth or accretion, begins instantly to decay; for as there is no cessation in the operations of nature, or the motion of atoms, or in the action of the power of affinity and attraction, there can be no cessation in the accretion or abstraction of atoms to and from a body.

A body once attained to the full maturity of growth or accretion, may continue to exist as a body for ages, and not totally perish; but during such period, the process of accretion and abstraction of atoms to and therefrom may be incessant, yet their accretion cannot permanently exceed the assigned limits, and abstraction may exceed the amount of accretion, and in proportion to such excess will be the amount of decay of such body or substance.

During the growth or accretion of a body or substance, the process of accretion and abstraction may proceed simultaneously, and the process of abstraction may be necessary to facilitate and ensure the required accretion. And during the decay of a body, the process of accretion and abstraction may proceed simultaneously, and the process of accretion may be necessary to facilitate and ensure the required abstraction, and the amount of abstraction being greater than the amount of accretion, the decay of the body or substance necessarily occurs.

Concurring circumstances favoring the decay of a body, or substance, the process of abstraction of atoms from such body or substance may continue until the two last atoms of composition of such body or substance are disunited; or the process of abstraction may be temporarily retarded or suspended, and accretion again occur to the limits of capability.

The reproduction of a body or substance requires the partial or total decay of one or more bodies or substances, to furnish the atoms necessary for the formation of the required body or substance; for as there is no present chaos or magazine of unemployed atoms in space, for the formation of new bodies or substances when old ones decay and totally perish; and as atoms are imperishable, the formation of new bodies is effected with the atomic materials of those which are partially or totally destroyed.

As an illustrative instance, if we attend to the minutiæ of the reproduction of grain, we shall find that the partial or total decay of one seed, is necessary for the reproduction of many; and in addition, the partial or total destruction of a quantity of water and air must also be effected, in order not only to ensure the reproduction of one other seed but of many; and it must be quite obvious, that if the whole of the atoms of which one seed is composed, were alone used for the reproduction of a similar seed, there could not possibly be any to spare for the formation of more, and the work of reproduction would be useless; but the wise and beneficent author of all things, has ordained that in the process of reproduction, the original body or seed, shall furnish the nucleus atoms for the reproduction of many, and that the atoms of accretion shall be furnished by the partial or total decay of other bodies or substances; and it is by this wonderful and admirable arrangement, that an incessant change of atoms is continually occurring, and the total wants of animate and inanimate bodies and substances supplied.

The partial change or conversion of one substance into another, such as grain into malt, and wort into beer, &c. is effected by the process of an accretion and abstraction of atoms.

PNEUMATICS, *a branch of science, comprehending the physiology of ærial fluids.*

All known substances may be classed under three heads, solids, liquid fluids and ærial fluids.

A solid is composed of ponderable atoms united in close contact, and held together by attraction of cohesion, and the interstices presented by their union, are partially or totally filled with imponderable atoms.

A liquid fluid is composed of ponderable atoms in close or proximate contact, mixed with a sufficient quantity of imponderable atoms, as is necessary to keep the ponderable atoms sufficiently far apart, so as to prevent their adhesion by the power of attraction of cohesion.

An ærial fluid is composed of ponderable atoms situated at some distance from each other, yet not beyond the sphere of mutual attraction, and kept apart by the imponderable atoms of heat, and yet are held in unison though not in contact, by the power of attraction of aggregation.

All known substances, whether solids, liquid or ærial fluids, are transmutable into either state by the addition or abstraction of heat.

All ærial fluids are elastic, their elasticity consisting in their liability to be compressed into a smaller bulk, either by mechanical pressure, causing an exudation of a portion of the atoms of heat, and a nearer approximation of the atoms of which they are composed, and being restored to their original bulk by an addition of an equal quantity of heat to that which has been lost, on the removal of the pressure; or by a chemical abstraction of a portion of the heat and a subsequent chemical addition.

Ærial fluids may be divided into permanently elastic and temporarily elastic classes; and we may select the atmosphere as the representative of one class, and steam or aqueous vapour of the other.

By the compression of air in a vessel, such as the air gun, &c. a large quantity of caloric exudes through the material of which the vessel is composed, and which may be indubitably ascertained, by placing the hand on the metal barrel of the air gun, during the compression of the air therein, and noting its increased temperature; and its permanent elasticity is evidenced by the violence with which it rushes from the barrel, as soon as the retaining valve is raised to allow its exit, which force results from the rapid return of an equal quantity of caloric to the condensed air as was expelled from it, causing the ponderable atoms instantly to resume their original situation, from which they had been removed by pressure.

Atmospheric air is a compound composed of a definite amount of oxygen, nitrogen and caloric, and in the process of its condensation in the barrel of the air gun, a portion of its constituent caloric is separated from the oxygen and nitrogen by pressure, and is forced through the interstices presented by the union of the ponderable atoms of which the metal barrel of the gun is composed; but none of the ponderable atoms of oxygen and hydrogen are forced through with the caloric, and consequently the integral state of the condensed air is not changed, with the exception of a diminution of a portion of its constituent caloric. Was it possible to force through a proportionate quantity of the atoms of oxygen and nitrogen with the caloric, the air retained in the barrel would be no longer elastic, because of such proportionate diminution. But as it is an established law of nature, that when a definite proportion of oxygen and nitrogen are mixed together (such as are the constituent proportions of air), then shall a definite amount of caloric combine therewith, provided the oxygen and nitrogen are in a state of freedom to receive it, so as the condensed air when liberated from the barrel of the gun, is in a state of freedom to receive the amount of caloric lost during its condensation, the amount is instantly furnished by the surrounding atmosphere as soon as it is liberated from the barrel; and from the view of the case it therefore will appear, that the elasticity of air, consists in the separation and restoration of a portion of its constituent heat, and the permanence of such elasticity, is dependant on the conservation of the relative proportions of the constituent oxygen and nitrogen.

Steam or aqueous vapour may be similarly reduced in bulk by compression, but if the pressure is removed, it will not resume its former bulk, because the caloric which has been forced from it, will not return, therefore the ponderable atoms will not resume the position which they occupied previous to the application of the pressure; and the reason why an equal quantity of caloric will not be imparted from the atmosphere to the ponderable atoms of oxygen and hydrogen of which the steam is composed in conjunction with the carbon expelled, the instant that the pressure power is removed, is because such caloric was not a natural constituent appendage to such oxygen and hydrogen, but merely an artificially impartive constituent; and as the constituent amount of the caloric of steam, is not an integral but an impartive amount, so is the elasticity of steam but temporary.

But abstractedly considered, steam is not even temporally elastic; for although in support of its elasticity may be adduced, the apparent fact of its condensation between the surface of the water in the boiler, and the upper part of the boiler, by its retention therein, and its increase by the addition of heat from the burning fuel in the furnace, and the great expansion to which it is subject the instant the pressure is removed; yet is such condensation and expansion, the result of an accumulation of heat in the metallic surface of the boiler and the materials surrounding it, which combines with inconceivable rapidity with a fresh portion of the constituent oxygen and hydrogen of the liquid water, the moment the boiler is relieved of its imprisoned vapour, and promptly creates an additional supply of steam, as soon as a vacant space occurs in which to generate it, by the departure of the amount first created; and when it is said that steam of so many atmospheres is generated and retained between the surface of the water in the boiler, and the upper part of such boiler, it is not to be inferred therefrom, that a large accumulated amount of the ponderable atoms of oxygen, hydrogen, and caloric, are collected in such space, and are condensed or compacted in a less space than they would occupy in a state of freedom in the atmosphere; but that a large quantity of heat is accumulated in the metallic surface of the boiler, &c. which cannot combine with the water in the boiler, until a vacuum is created in the space above the surface of such water by the departure of the steam previously generated; and that as soon as such departure occurs, the surplus quantity of heat which was thus accumulated, quits the medium in which it was stored, and rapidly passes by transition, induced by the law of equal diffusion, to the water in the boiler, and instantly creates an additional quantity of steam; and thus the increased amount furnished in a given period, and which is attributed to its prior formation and subsequent condensation, should be ascribed to a subsequent formation, by a rapid transition of accumulated heat to the water, relieved from the superincumbent pressure of the first amount of steam generated, which was sufficient to fill the space between the surface of the water and the boiler.

Steam consists of the ponderable atoms of which water is composed, and the imponderable atoms of heat which are imparted to it, and which separate the ponderable atoms, and place them at a greater distance one from the other.

Water and other liquid fluids occupy a middle station between solids and ærial fluids, and are convertible into either by the abstraction or impartation of heat; and to the existence of water in those three separate states, we may apply the terms, solid water, liquid water and æriform water.

But the natural state of water in the economy of creation may be said to be the liquid, as we have reason to suppose that in this state, it is more abundantly diffused throughout the universe; and that in such state it better corresponds with the average temperature of the atmosphere; and when existing out of such state by the abstraction of its caloric of fluidity to render it solid, or by the impartation of caloric, in addition to the amount of caloric of fluidity, up to the point when it assumes an æriform condition by the addition of such caloric, there is always a tendency in the ponderable atoms of which it is composed, to return to the medium position of liquidity.

As water in a liquid condition may be said to be in its natural state, and as water at a medium or low temperature is incompressible, so therefore may it be deemed inelastic; for as by the term elastic, we understand that peculiar property of a body, which admits of a diminution of its bulk by pressure, and upon the removal of such pressure it instantly resumes its original bulk, so steam, not possessing such property of resumption, must be deemed inelastic.

The ponderable atoms of water and air, consist each of two classes or species, and both are compounded of definite and invariable quantities of each, with a definite quantity of caloric; and providence has wisely ordered, that whenever an assemblage of the right quantity and proportions of the required ponderable atoms occur, that a sufficient quantity of atoms of heat shall unite with them, to constitute the liquid and ærial fluids in their natural state; and by such arrangement, those elements subserve all the purposes of physiological economy; and the re-formation of those elements are continually occurring by the union of the proper species and quantities of atoms that are liberated by the continual decomposition of bodies, and thus the re-formation of water and air to an amount equal to the consumption of nature in the formation of new substances and bodies is insured and provided for, by the proportionate blending of the atomic materials of those which she partially or totally destroys.

The natural state of pure air in the physiological economy is gaseous, consisting of a definite, proportionate and invariable quantity of two classes of ponderable, and one class of imponderable atoms to a definite and invariable constituent amount, but to an indefinite and variable thermometric amount. But the atmosphere is not pure air, as it is mixed with a variety of gases and vapours of which it is the recipient; and from the admixture of two of those gases in correct proportions, the re-formation of air is continually occurring; and in illustration of the need of such a recomposition of pure air, we may refer to the fact, that all animals decompose air in very large quantities in respiration, abstracting the oxygen therefrom, and emitting the nitrogen; and if no provision had been made for the re-formation of pure air, the whole mass of air which surrounds the earth, however great the bulk, would yield a supply of oxygen, infinitely inadequate to the required need, but we need not look far for one of the sources of supply of the oxygen which is required to unite with the nitrogen emitted from the lungs of animals, for the re-production of pure air; as every tree, plant, shrub and vegetative substance, is emitting oxygen from the upper surface of their leaves during the continuance of the day, and abstracting carbonic acid gas from the atmosphere emitted by perspiration from the bodies of animals, and from other sources, by the absorption of the vessels which ramify the under surface of their leaves; thus illustrating the beautiful harmony, with which the functions of life, of animate and inanimate bodies are mutually supported—the animate requiring the excretory products of the inanimate to support life, and the inanimate those of the animate.

The atmosphere is the recipient of all the gases and vapours which result from the decomposition of all terrestrial substances, and is likewise the dispenser of all it receives, for the innumerable demands and purposes of nature and art. The various classes of atoms which it receives above the needful portion of oxygen, to furnish the amount abstracted by respiration, &c. is held by it in a state of simple mixture, and wafted from the recipient regions to all quarters of the globe, dispensing sustenance and support to every thing upon its surface: it furnishes the sustenance of combustion to fuel, and receives the heat and aqueous vapour, which are the resulting excretory products of their several processes; and aids their various manipulations as a chemical and mechanical agent.

PONDERABLE, *capable of being weighed.*

All known substances are ponderable, because they are compounded of ponderable atoms commixed with imponderable.

The ponderable property of an atom consists in the gravitating power or tendency to fall toward the earth with which it is invested; and as each atom possesses a distinct and definite amount of such power, the gravitating power of a substance is proportionate to the aggregate amount of the gravitating power which the ponderable atoms of which it is composed separately possess, and the quantity of imponderable atoms with which they are mixed.

The ponderous property of a substance, floating, or suspended in or falling through atmospheric air or water, is the same, and of the same amount as in vacuo, but the velocity of its fall toward the earth is widely different, for if it falls in vacuo there is nothing to oppose it, but if it falls in air, water, or other fluid, its progress is impeded by the fluid through which it passes, and the amount of the resistance thus presented is proportionate to the relative specific gravity of the falling substance, the force of the upward and lateral pressure of such fluid, the surface which the substance presents to the resisting medium, and the altitude from which it falls.

The gravitating power possessed by a substance or body, is the operating power of affinity and aggregate attraction which subsists between the ponderable atoms of which the body and the earth are composed.

The greater the constituent amount of the ponderable atoms of a body, and the less the space which they occupy, the greater is the amount of gravitating power which it possesses, or in other words, the greater is its relative ponderosity.

To ascertain the weight of a body is to discover the amount of its gravitating power, or the power of affinity and attraction of aggregation which subsists between the ponderable atoms of which such body is composed, and the ponderable atoms of the earth.

PORTER, *a species or peculiar sort of beer.*

The legitimate materials from which porter is brewed, are either pale and patent roasted malt, pale and brown malt, or pale, amber, and brown malt mixed in various proportions, as taste, opinion, and circumstances may induce, with the usual accompaniment of water, hops, and yeast.

Porter differs from ale in color and flavor, in consequence of the use of high dried or roasted malt in admixture with pale, and the cause of the higher flavor and color of high dried or roasted malt, is the impartation of more oxygen to the malt on the kiln or in the roasting apparatus, than is imparted to pale malt;—the oxygen in combination with the substances composing the malt furnishing both the color and flavor, and the intensity of both being governed by the amount of oxygen which may be imparted and combine with those substances.

Atmospheric air is the source of supply of the required oxygen, and caloric is the agent by the aid of which the impartation is effected; and as the requisite supply of oxygen is very great for the impartation of a sufficient intensity of color and flavor to brown malt, so a large amount of the agent caloric, is necessary to aid the decomposition of the air which comes in contact with the malt, in its transit through the perforated floor on which the malt is laid, and the impartation of oxygen thereto; and a large amount of air is requisite to furnish the supply of oxygen needed.

The malt which is laid on a perforated floor for the reception of caloric to expel the residue of the water which it imbibed in steeping or sprinkling, and which has not been expended in the process of germination by the conversion of such water into vapour by the addition of heat; also for the reception of oxygen from the air for the purpose of converting a portion of the gluten of the grain into fecula, and fecula into gum and saccharum, and also for the supply of the requisite color and flavor, is liable at the same time to receive an ill flavor from any gases or vapours which may emanate from the burning fuel, and which the malt may be able to retain in combination, and the properties which are of an objectionable character; and it therefore is necessary to select such a species of fuel, and in such a state and condition for combustion, for the drying of malt, (particularly such as is to be highly dried) as will not yield gases or vapours, which are able to impart an ill flavor to malt.

The air consumed in the drying, saccharification, and impartation of color and flavor to malt is immense, and proportionate in amount to the intensity of color and flavor imparted, and the combustion of the fuel to furnish the requisite heat to aid the impartation of oxygen, and to effect the conversion of the water in combination with the grain into vapour.

All the air which passes through the furnace bars, and the oxygen of which combines with the fuel to support its combustion, is useless for the purpose of the impartation of color and flavor to the malt; but the nitrogen which passes from the fuel to the malt through the perforated floor, serves for the conveyance of a considerable portion of heat to convert the water in the malt into vapour, and to aid in the impartation of the oxygen from that portion of the air which passes over the burning fuel to the malt, for the several purposes for which it is needed. It is to facilitate and admit of this transit of undecomposed heated air to the malt on the kiln, that no door is affixed to many malt kiln furnaces as is usual to a copper furnace, and why the floor is perforated; and to some kilns whose dimensions are large, and the aperture above the burning fuel is not sufficiently large to admit enough air, it is usual to form the sides of the furnace with cast iron plates, and leave an aperture in the wall on each side of the furnace for the passage of air by the heated plates, to sweep off the caloric therefrom for the purposes before adverted to, and the dimensions of such apertures are enlarged, diminished, or closed at pleasure, by suitable sliding doors.

Irrespective of the production of color and flavor, the impartation of oxygen to malt on the kiln, causes the formation of carbonic acid; and the accompanying heat which facilitates the impartation, also converts such carbonic acid into gas; and being so converted it evolates from the malt, and such evolation will account for the greater loss in weight of high dried malt, to that which is sustained by pale dried, the difference arising from the impartation of a greater amount of oxygen to the former, and the consequent larger amount of carbonic acid gas created and lost by evolation.

To such cause also may be attributed the possession of a smaller amount of soluble extract by high dried malt than pale, because of its loss by evolation in the form of carbonic acid gas, and for the same reason it must be obvious, that high dried malt possesses a less amount of fermentable material than pale dried, because it has lost more of its carbon in the process of drying on the kiln.

To the same cause also may be attributed the superiority of porter to ale, as a beverage for invalids, or those whose digestive powers are weak; for as both ale and porter in the usual state of consumption, consists of a considerable portion of unfermented extract of malt, it necessarily follows that as the extract of pale malt contains more carbon than that of brown, that more oxygen is needed for the decomposition of the unfermented or undecomposed extract of ale than that of porter; and as the required oxygen must be furnished by the gastric juice, which is the digestive agent, so those who from age, disease, or other incidental causes, do not generate a large supply of gastric juice, require a beverage which needs the least decomposition.

As the extract of brown malt furnishes a smaller amount of the fermentable principle than such as is drawn from pale malt, so in fermentation it is productive of a smaller amount of excretory materials, and is rendered transparent with more facility.

As brown malt receives more oxygen and heat on the kiln than pale, and consequently loses more carbon, by the creation and evolation of carbonic acid gas, so the extract therefrom containing less carbon than the extract from the pale malt, a porter wort is not so liable to an acetous fermentation as ale wort, because the former possesses a smaller amount of the power of affinity and attraction for the oxygen of the atmosphere than the latter, and is therefore, not so liable to its impartation in excess, in amount and rapidity, nor more than a vinous fermentation requires.

POWER, *strength, ability, authority, influence, &c.*

The term power may be considered under three divisions, mental, instinctive, and physical.

Such power as is derived from or exercised by the human mind, is superior to the instinctive or physical, in the attributes of conception, design or execution.

Instinctive power is superior to physical, and is a link between the mental and physical.

Physical power is but the unconscious expression of animal strength, rendered intelligent by mental or instinctive communication.

The mental or instinctive faculties having impressed on the nerves and sinews, the conception, the design, and the mode of accomplishment of an action, they tacitly obey the bidding, if the performance is within their power; and if the performance is not within their power, then such faculties devise and call in aid, such auxiliaries as are suitable and competent in conjunction with physical power to accomplish the task assigned.

Thus the mind conceives the necessity or advantage of moving a body; it calculates upon the capabilities of the muscular power subject to its control; it commands their attempt, and directs the method of their application. They may be equal to the task, it is performed, and the mind approves. They may not be equal, and the mind directs the assistant application of the lever, the screw, or a variety of other mechanical engines, and the deed is done.

It is said that " knowledge is power." Instinct is intuitive knowledge, or its seed, sown in the mind at the moment of conception, wherein it germinates until the birth, from which state it passes into the vegetative state of intelligence, which is intellectual or acquired knowledge.

If the instinctive seed is weak, defective, or sown in a barren soil, it germinates feebly, and becomes a sickly plant; but if it is strong, sound and imbedded in a rich soil, it develops favorably, and unfolds a plant of promising growth.

But it is the after culture of instruction, the beams of bright example, the waters of benevolence, the air of truth, the prunings of prudence, the stimulants of enterprise, and various impulses beside which regulate the growth and reveal the characteristics of the mind.

PRACTICE, *performance, habit, use, exercise, method, &c.*

Practice may be considered as antipodal to theory. Theory the conception of a performance, and practice the execution of it.

Some are ever theorizing and others ever practising; happy he, who adopts the medium as his rule.

The staunch practitioner pities the theorist, and the exclusive theorist contemns the practitioner, while the medium truist takes council from them both.

Practice upbraids theory with the analysis of his methods, and thus obtaining knowledge of his secrets; and theory reproaches practice, with robbing him of his systems without acknowledgement, and claiming the offspring as his own, while the truist arbitrates between, and gives to each his lawful due.

Practice says, " I will not improve, let well enough alone"; and theory says, " I will pursue and never stay to glean"; but the truist says, " I will pick up all they leave behind."

PRINCIPLE, *constituent part, original or operative cause, fundamental truth, notion, tenet.*

It has been indubitably proved, that all known substances are divisible into what are occasionally called atoms, particles, and ultimate principles; but the form, size and properties of such constituent principles being imperceptible to the human sight, they can only be judged of by analogy; and as the inferences of reason vary, so are the relative conclusions various, and several hypotheses have been framed by eminent men, each having their advocates, and we profess to be the disciples of the author of the atomic system.

Mere speculative theories which lead to no profitable result, prove but a waste of the projectors' and the readers' time, but man finds himself floating down the stream of knowledge far distant from the source; and admiring the vast expanse, and the extensive utility of the rippling flood, which is conveying him onward to the ocean of eternity, he ever feels a desire to trace its course through all its meanderings, up to the parent source, noting in his progress, all the tributary streams which contribute to its increase.

Thus in the present day, we find ourselves floating in metal, the specific gravity of which is greater than the water which bears it; onward impelled by the power of steam, with more rapidity than a hurricane would enable; and illuminated by a burning vapour, which yields a more brilliant blaze than the corruscations of any meteor; and surrounded by such and many other modern wonders, can we but wish to trace the nile of knowledge to its fountain source.

What then can be more natural, consistent and praiseworthy than the enquiry, why an iron ship can swim? why the vapour of quiescent water can furnish a force superior to the fleetest wind? And why the gaseous product of combustion, can yield a flame more brilliant than the solid coal or fluid from which it emanates.? And what is the result of such enquiry? a discovery of gravity and specific gravity; and although a bulk of iron is much heavier than an equal bulk of water, yet if it is rolled or beat into thin plates, and formed into a hollow vessel of sufficient capacity, it will float upon its surface, because the weight of the vessel, its solid, liquid, and ærial contents are together of less specific gravity or weight, than an equal bulk of water. A discovery is also made, that the atoms or ultimate principles of heat, are subject to the power of equal diffusion; and that the impartation of heat to water by medium of burning fuel, is sufficient to generate steam, and to impart to it an extensive and astonishing power; and which power may be curbed, directed, controlled or annihilated in an instant by the abstraction of the imparted heat.

Again it is found that by the distillation of coal, oil, and other substances, or by the impartation of heat to the ponderable atoms of which they are composed, that a gaseous product may be obtained, called carburetted hydrogen gas, which with the addition of oxygen derived from the decomposition of air, or obtained from other sources, furnish a brilliant, pure, and economic illuminating light, or a convenient and well adapted source of heat. And for these and various other important discoveries, we are indebted to the researches of those who have endeavoured to trace the stream of knowledge to its fountain head.

To dissect a substance by analysis, and re-produce it by synthesis, requires a knowledge of the first principles, which ennobles its possessor beyond the titled gifts of kings, and ranks him a useful ornament to the age in which he lives.

PUMP, *an engine for the raising of fluids.*

Pumps are constructed of various materials, for the withdrawing, raising, and propelling both ærial and liquid fluids, and of a great diversity of form and mechanism, but there are but three recognized distinct principles of construction, and which are termed the common lift, the lifting force and the forcing lift, and it is quite desirable that every manufacturer as well as plumber, should well comprehend each principle, and their peculiarities of difference.

The common lift pump is the most simple in construction, of the least cost, and requires the least amount of labour in operation. Its parts consist of an open head for the reception of the fluid raised, with a spout for its delivery, a cylindrical barrel connected with the head, of a length somewhat exceeding the length of stroke, or the rise and fall of the piston therein; a piston and rod, connected with (generally) a lever handle, which piston is generally formed of a hollow cylindrical piece of wood, on the exterior circumference of which, is affixed a cylinder of leather and which piston is made of such a diameter, as is sufficient to fit the barrel of the pump sufficiently tight, to prevent the passage of air or water between the piston and the barrel, but not so tight as to be either immoveable or subject to great friction; and the upper surface of the hollow part of such cylinder of wood is covered with a clack valve, and the under part left open; and this piston is usually called the bucket, and to it is fixed an iron rod which is connected with the lever.

A cylindrical pipe (usually called the suction pipe) is connected with the lower part of the barrel, and is of sufficient length, as nearly to reach to the bottom of the well, and at the point of union between the barrel and the suction pipe is fixed a spindle valve. To illustrate the action of this pump, we will first suppose the pump barrel and the suction pipe to be full of air, except such part of the suction pipe as dips into the water; next that the pump handle is raised, and consequently the piston is forced down too near the bottom of the barrel, and in passing down it compresses the air in the lower part of the barrel, until it acquires an elastic force, more than equal to the resistance of the clack valve in the piston, and the weight of air above it, and the clack valve then rises, and allows a portion of the compressed air to pass by it; and for illustration sake, we will suppose the quantity to be equal in measure to one quart. As soon as the descent of the piston ceases, the clack valve falls by its own weight. The pump handle being next depressed, the piston is consequently raised nearly to the top of the barrel, and as it fits sufficiently close to it as not to allow any air to pass by its sides, and the clack valve is kept down by its own weight and the pressure of the air above it, so then as much air as occupies the space in the barrel to which the piston rises, is lifted up and ejected from the head or spout; and if the valve at the bottom of the barrel was fixed, there would be a partial vacuum between such valve and the clack valve—partial only, because a small portion of air would be left behind on the closing of the clack valve, and which in the raising of the piston would be rarefied and occupy the whole space, but in such a state would present a force of resistance unequal to the subsequent pressure of the air above the piston. But as the valve at the bottom of the barrel is not usually fixed, but is purposely fitted so as to rise and fall with, freedom, so the moment the piston rod is raised, the moment does such valve rise, and the first resulting effect is, that the air contained in the suction pipe will expand to a trifling extent too, and a small portion pass by such valve sufficient to render the tenuity of the whole equal; and was there no other resulting consequence, water would never rise up to the suction pipe; but from what has been said, it is evident that the barrel of the pump and the suction pipe, contain one quart of air in its natural state, less than they did before the piston was raised; and consequently one quart of water more will enter into, and rise in the suction pipe, and the air will be restored to its natural tenuity. But we have now to enquire, what caused the quart of water to enter into and rise in the suction pipe, and we must therefore first refer to the weight of the atmosphere which pressing on the surface of the water in the well, is the primary cause. It is supposed that the atmosphere which envelops the earth, extends to a height or distance of about 45 miles from its surface, and that its pressure on the surface, is equal to about fifteen pounds on every square inch; and that its pressure on the surface of water, is equal to the weight of a column of water about 35ft. in height. If then the whole of the air was withdrawn from the suction pipe and pump barrel at one upward stroke of the piston, the pressure of the atmosphere upon the surface of the water in the well, would cause as much to rise as would fill them, provided the height of the piston above the surface of the water in the well did not exceed about 35ft. But as the one upward stroke only withdrew one quart of air, of course no more than one quart of water could be forced up. Then how is the water eventually to reach the piston, pass through the clack valve and reach and run out of the spout? the method is plain and obvious! The motion of the piston must be continued, withdrawing quart after quart of air until the whole is withdrawn, the water as gradually ascending the suction pipe and pump barrel, until it ultimately reaches the spout, and from which it may continue to flow, while the action of the piston is continued. It has been stated, that the pressure of the atmosphere is equal to the weight of a column of water of about 35ft. and that by the withdrawal of the whole of the air from the suction pipe and pump barrel, that water would rise therein to the height of about 35ft. but this must be considered more mathematically than practically correct, inasmuch as friction and the variable density of the atmosphere will both contribute to the prevention of such an effect; and it is customary with plumbers in order to make due allowance for all retarding forces, to place a common lift pump to a well whose depth is not more than 28ft. and to such as are deeper, to place either a forcing lift, or a lifting force pump, and in such case to fix the pump barrel within 28ft. of the bottom of the well.

The lifting force pump is constructed similar to the common lift pump, with the exception that the head is closed, instead of being left open, and that the spout instead of being open and delivering water below its own level, is connected with an ascending pipe called a rising main, up which the water is projected or rather lifted, by every upward stroke of the piston. And it is here necessary to explain, that when all the air is withdrawn from the suction pipe and pump barrel, that every time the piston is forced downward, the resistance of the water below the clack valve to the descent of the piston, forces the clack valve open, and as soon as the descent ceases, the valve shuts down by its own weight, and therefore when the piston is again raised, all the water above it must be raised also; and if the spout of the common lift pump was closed, as much water would run over the head as passes by the clack valve on the descent of the piston. As to raise water above the head of a common lift pump, it is necessary to close the spout, so it is necessary virtually, though not actually, to close the spout of a common lifting force pump, by fixing to the spout a valve, and above such valve a rising main. But the intention of a lifting force pump, is not to close the delivery spout with a valve in order to cause the water to flow over the head, as that would be to return water (comparatively) to its source—the well; and therefore to prevent such an effect, a close head is placed on the pump barrel, minus an orifice in such head through which the piston rod passes; and in order that such orifice may be sufficiently large as to prevent unnecessary friction in the ascent and descent of the piston rod, a small cavity is left in the head into which is inserted a sufficient quantity of hemp, in the state called tow, surrounding the piston rod; and such tow is screwed into such cavity sufficiently tight to prevent the passage of water, but not so tight as to impede the motion of the piston rod; (which cavity is called the stuffing box) but the intention of the valve in the delivery spout, is to take off the weight of the column of air or water in the rising main, from the column of air or water below, as otherwise, the moment the clack valve is opened, the column of air or water above the water in the well, is no longer 28ft. or 35ft. but as much higher, as may be the length of the column of air or water in the rising main; and in such case the pressure of the atmosphere upon the water in the well, being no more than adequate to raise water from 28ft. to 35ft. in height, it would become a useless apparatus for raising water to any greater height.

To comprehend this more fully and clearly, let us again examine the action of the piston in such pump and the resulting effect. Before the piston commences its descent, the height of the column of water in the suction pipe and pump barrel is 28 or a few more feet, and consequently the pressure of the atmosphere on the surface of the water in the well, is equal or more than equal to the weight of such water in the suction pipe and pump barrel, and therefore it is sustained therein by the atmosphere. We will next suppose that the rising main is full of water, and that without causing any motion of the piston, the valve in the delivery spout, and the clack valve and the suction valve are both raised; it must then be obvious, that the column which was divided by the three valves becomes now connected, and forms but one column instead of three, as before they might appropriately be called; and in such state if of greater height than about 35ft. as much water will run out of the bottom of the suction pipe, as will reduce the column in height to the limited extent of the sustaining pressure of the atmosphere. Now let the imagination view the piston in its descent; and although the clack valve opens, it will be perceived that the delivery spout and suction valves remain shut, and consequently the column of water in the rising main is separated from the column in the pump barrel and suction pipe, and therefore the sustaining pressure of the atmosphere is not opposed and overpowered by a superior weight, in consequence of the opening of the clack valve only. The descent of the piston being terminated, the clack valve closes; but what is to become of the water in the pump barrel that is now above the clack valve, and is carried upward by the piston in its ascent, and which is not able to escape by the head as it is closed? The answer is evident! it must pass by the delivery spout valve, which is opened by the upward pressure of the intervening water between that and the clack valve, which water is raised by the piston; and as such rising ceases as soon as the piston ceases to move upwards, so as soon as the pressure of such water upon the valve ceases, so soon does it fall by its own weight, and prevents the return of the water which has passed by it; and the consequent effect is, that as one quart of water passed by such valve, and as previous to its passing, the rising main was quite full, so one quart of water must be forced out of such rising main, by the forcing in of one quart.

The forcing lift pump differs in construction from the lifting force in two essential points ; in the formation of the piston, and the situation of the delivery spout. The piston of such a pump is called a " plunger" instead of a " bucket," and which forces the water up the rising main by its descent in the pump barrel, instead of raising it up by its ascent. A plunger piston is usually a solid cylindrical piece of wood, accurately fitting the barrel of the pump, sufficiently tight, as to prevent water from passing by it in its ascent and descent, and not so tight as to prevent its motion; and in some cases the diameter of the plunger is less than that of the barrel, and as much less as will admit of its periphery being covered with leather, so as that the wood and leather together will accurately fit the pump. The piston rod works through a stuffing box at the top of the pump barrel, and the delivery pipe is fixed in the side of the lower part of the pump barrel, instead of the side of the top part as in the lifting force pump. A valve is also fitted into the delivery pipe, and another at the bottom of the barrel called the suction pipe valve. The action of this pump is as follows: we will first suppose that the suction pipe dips into the water contained in the well, and that the pump barrel is fixed, within 28ft. of the bottom of the well, and that the barrel and suction pipe is full of air above the water, and the handle of the pump is down. The first operation is to raise the pump handle, and consequently to cause the descent of the piston to the bottom nearly of the pump barrel, and the air beneath the piston being compressed exerts an equal pressure on the delivery spout or rising main valve, and forcing it open, as much air passes by it, as was contained in the pump barrel between the situation of the piston, previous and subsequent to its descent. The next operation is to depress the pump handle, and consequently to raise the piston, and the effect is to create a vacuum, and it would be to the extent of the rise of the piston, if the suction valve was fixed; but as it is not, such valve rises at the commencement of the creation of the vacuum, and the air in the suction pipe rushes by and fills it up as fast as it is created; and the water in the well being pressed upon by the atmosphere, it ascends the suction pipe as fast as the air is withdrawn from it; and thus by the repeated descent and ascent of the piston, all the air is withdrawn from the suction pipe, and expelled from the pump barrel by the rising main, until water flows into the pump barrel, which in its turn is also withdrawn from the suction pipe, and expelled from the pump barrel in continuation as the air had previously been.

The suction pipe valve fulfils the same duties for the threefold description of pumps, and is for the purpose of preventing the expulsion of the air or water from the suction pipe, by the pressure resulting from the descent of the piston in the pump barrel.

In referring to the practice of plumbers in placing the barrel of any description of pump within the distance of 28ft. from the bottom of the well, it is to be understood that the purport of so doing, is to enable an easy draught of water, provided the well is nearly empty, and that there is but enough to cover the draught holes at the bottom of the suction pipe; and in stating that the pressure of the atmosphere is able to force water up the suction pipe and pump barrel to the height of from 28 to about 35ft. it is to be understood that the height is to be calculated from the surface of the water in the well, whatever may be its depth, and not from the bottom of the well.

PUTRID, ***rotten, corrupt, offensive, disgustful.***

Amid the numerous and admirable dispensations of providence, not the least wonderful is that arrangement, by which many of the most fragrant and odoriferous substances, are subject to a change from a grateful to a most noisome description; and that the putrid decomposition of substances should contribute to the formation and growth of much that is lovely, fragrant, and grateful to the senses.

A partial or total extinction of the principle of life, appears to be the prelude to such an organic change.

To us the principle of life appears to be neither more or less than the impartation of oxygen to the animate or inanimate body, in regular and gradatory supplies, to one or more recipient organs, by which it is transmitted and diffused throughout the whole of its parts, and entering into combination with other species of atoms, and thereby renewing and replacing those portions of such bodies, as are continually subject to abstraction in various ways, and effected by various causes.

The impartation of oxygen to bodies, is the chief principle of motion, and the chief agent in the process of decomposition and recomposition, and appears to be that salutary principle which first generates life, and then supports and maintains it; and without a continuation of the supply, the principle of life is immediately extinct.

Life may be termed a chemical process of decomposition and recomposition, wherein oxygen is the moving power, and to cut off the supply of power to the animate or inanimate machine, is at once to cause the cessation of motion.

Putrid.

If an enquiry is made relative to the details of the process of existence of all animated beings, it will be found that they are all provided with a stomach for the reception of some peculiar food that is well adapted to support and maintain the principle of life in them; that such food is subject to decomposition, a portion of the products being appropriated to the formation of blood, nervous fluid, &c. and the residue consisting of gaseous, fluid, and solid excretory products, is expelled from the body.

The mechanical action of mastication, and the admixture of the comminuted food with saliva previous to its admission into the stomach, is but for the purpose of assisting the process of decomposition, which is finally effected by a fluid called gastric juice, which being compounded with a large portion of oxygen, a chemical combination of such oxygen with the several species of atoms of which the food is composed occurs, and from which result those compound fluids and gases, which it is necessary should be transmitted by diffusion throughout the whole of the animal system, and by such decomposition the latent heat of such food is rendered active, and being imparted to the new compound, assists in the formation of the several fluids and gases, and facilitates their diffusion. The fluids and gases which are thus formed to flow through all the ramified canals which pervade the body, for the purpose of conveying nutriment by accretion to every part of the system, would soon lose their heat and become solid ere they had reached their destination, and fulfilled the purpose of supporting and maintaining life, choke up those canals, and ceasing to yield their sustenance, the principle of life would soon become extinct in all those parts which were deprived of its circulating presence; and in the several cases of paralysis, chilblains, tumours, wounds, ulcers, &c. it will be found that a defective circulation is often the cause of such and other maladies to which the animal system is subject; and where the cessation of circulation is total, putrefaction very soon occurs. On the supposition that the latent heat of food rendered active by its decomposition was sufficient to furnish a supply equal to the amount of abstraction from the surface of the body, and to continue the circulation of the several fluids and gases throughout the system, yet would the small amount of oxygen furnished by the gastric juice and the food, be totally inadequate to the requirements of the animal system, and failing in the necessary supply, life would soon become partially or totally extinct. But happily we find an inexhaustible fund both of heat and oxygen, more than commensurate to the demand of every created being and inanimate substance, in the atmosphere, dispensing universal life; and as the stomach is the recipient vessel for food, in which it is decomposed and from which the various products of such decomposition pass onward to and for the ultimate purposes of their destination, so are the lungs of animals the receptacles of atmospheric air in which it is decomposed; and the oxygen and a considerable portion of the heat which is imparted to the blood, which circulating through them, receives those elements and conveys them with stimulated alacrity to the remotest boundaries of the system, deposits them throughout its extensive meanderings, and ever and anon returning, receives another vital freight.

A great variety of familiar instances may be adduced to prove that the presence of oxygen is necessary to the preservation of life, and the presence of carbon to the prevention of putridity. Thus if an animal is precluded the respiration of atmospheric air and its decomposition, and the impartation of its oxygen to the blood is not effected, it dies, and the flesh soon becomes putrid, unless permanently or temporarilly preserved from corruption by some substance containing a large amount of oxygen as one of its constituent principles, such as salt, sugar, spirits, all the variety of acids, &c.

Nor are a great variety of solids alone subject to putrefaction, but many fluids also, and particularly those which are of animal and vegetative origin; and even vinegar which contains so large an amount of oxygen is liable to putridity, as soon as the whole of its oxygen and carbon has departed by evolation.

The putrefactive is the final stage of fermentation when the three stages occur in regular succession; but the putrefactive may occur in conjunction with, or previous to the vinous and the acetous, the condition being, the addition of a putrefactive ferment.

By the addition of a vinous ferment to a fermentable fluid, the decomposition of such fluid commences and continues by the addition of a portion of the oxygen of the atmosphere to the carbon of the wort, the atoms thus united forming carbonic acid, which is converted into carbonic acid gas, by the conversion of latent heat into active as a consequence of decomposition, and such heat uniting with the carbonic acid, renders it specifically lighter than the atmosphere and therefore it evolates from the fluid; at the same time a combination of a portion of the oxygen of the atmosphere is effected with the hydrogen and carbon of the fluid and forms spirit; and as a necessary condition to prevent the formation of acetous acid in such fluid during the vinous fermentation, the impartation of oxygen for the formation of carbonic acid and spirit must not be in excess, either as to quantity or speed, lest a third compound, acetous acid, is created in conjunction with the others.

By the addition of a putrefactive ferment to a fermentable fluid, the decomposition of such fluid is effected in a different way to what it is by the addition of a vinous or an acetous ferment—the effect assimilating to the cause, for as the vinous ferment consists of oxygen and carbon in conjunction, the acetous of oxygen, carbon, and hydrogen, the putrefactive of oxygen, hydrogen and nitrogen, so the impartation to a fermentable fluid, of a ferment in which either of those atomic compounds principally exists, will cause the commencement and continuation of a fermentation, analogous to the predominant substance administered as a ferment.

Thus if we take yeast as the proper ferment for a wort compounded of water and an extract from malt, if such yeast is the produce of a wort that has undergone a good vinous fermentation, and has been properly preserved since its ejection from such wort, it will cause a similar fermentation in the succeeding wort, all other circumstances favoring the operation. But if after the separation of such yeast from the wort, the impartation of oxygen to it is in excess beyond a combination with the carbon of the yeast, then will such yeast be converted into a vino-acetous or an acetous ferment. And again, if the impartation of oxygen to such yeast, is in amount sufficient to abstract part or the whole of the carbon possessed by such yeast in the form of carbonic acid gas, or if the carbonic acid gas enclosed in the vesicles of the yeast is nearly or quite lost by their rupture, induced by heat, &c. then will such yeast become converted into a putrefactive ferment, by the combination of oxygen imparted by the atmosphere, with the hydrogen and nitrogen of the yeast.

Thus it will appear evident, that as the presence of carbon, carbonic acid, or carbonic acid gas in yeast, in sufficient quantity is necessary to cause a vinous fermentation, so an abstraction of any portion of such as it possesses at the time it is separated from the wort, causes a diminution of its fermentative powers; and if the abstraction is beyond certain limits, then does such yeast become a conjunctively vinous and putrefactive ferment; and if the whole of the carbon it possessed in any state of combination is abstracted, then does it become a putrefactive ferment only.

That the presence of carbon is necessary to prevent and remove putridity, the frequent use of charcoal as a disinfector is a proof; and that the presence of nitrogen in excess is the cause of putridity will appear also evident, by the facility of its removal, by the creation of oxygen gas to serve as a disinfector; in either case the combination of the carbon or oxygen with the nitrogen, creating a new and salutary compound.

Both wort and yeast in a vinous condition, are compounded of distinct species of atoms in correct proportions, and in a proper state of arrangement; and are subject to a change from such state, to a conjunctive or separate acetous or putrefactive state, either by the addition of oxygen from the atmosphere, or abstraction of carbon from the wort or yeast, or both, or to a disarrangement of the component atoms; and brewers as well as others, will do well to observe; that as the atmosphere is the medium of the impartation of oxygen, and the abstraction of carbon, and that heat facilitates both one and the other, so therefore every necessary precaution that can be adopted to prevent the baneful effects, resulting from an improper and unnecessary exposure to an oxygenated and heated atmosphere will well repay all the attendant labour, care and expense.

RADIATE, *to emit rays, shine, sparkle, or transmit light, and heat.*

However pleasing, instructive and useful may be the subject connected with the radiation of light to the manufacturer, yet to that class for whom we write, it is but of secondary importance, while the radiation of heat is to them a subject of primary consideration.

All manufacturers whose manipulations are performed by the agency of heat, should be well versed in the subject of the radiation of heat; for as the obtainment and appropriation of heat is expensive, so is it necessary to comprehend the means of obtaining it at the least cost, and of appropriating it with the least waste.

If the rapid impartation of heat to the substance which is the subject of manufacture is of the first importance, the enquiry of the manufacturer should be directed to discover the fuel that will furnish the most heat within the limits of the required period, consistent with the cost, as compared with the value of the time occupied in the impartation, or the advantageous results as to the equality of the produce. And as heat is evanescent, he should discover the most suitable medium of its communication; and the state and condition as well as the form, situation, and circumstances of the medium of its transmission. Nor should he be unacquainted with the means of preventing all possible loss of the heat generated, and its full and proper impartation to that medium.

But if on the contrary the slow impartation of heat is of the first consequence, the choice of fuel subject to slow combustion should be made, or the means to regulate the combustion, with a speed proportionate to the need should be obtained, and the economy of impartation under every circumstance consistent with the purpose sought for should be well understood.

To refer to the brewer's purpose in illustration of the first case, a prompt, rapid and economical impartation of heat is desirable and requisite in every department of the process wherein its agency is needed. His first and subsequent liquors for mashing, &c. require to be heated with promptitude, in order to prevent any unnecessary delay in the process of brewing, as relates to loss of time and chemical effects to the products; and his worts require rapid ebullition, in order to ensure a sufficient coagulation of gluten and extraction from the hops, without occasioning chemical injury to the raw wort upon or off the goods, by too long an exposure to the atmosphere, while laying waiting for their transition to the copper. The brewer has then to consider and enquire, how many vessels may be sufficient, in which to heat his liquor for mashing, &c. and scalding utensils, &c. and to boil his worts; and also their size, form, and material of construction, the mode of fitting them up so as to ensure the impartation of as much heat to the liquor or wort, from the least quantity of fuel; so as to prevent the loss of as much of the heat that is generated as is possible, and to appropriate as much of that heat to a secondary purpose which has fulfilled a primary, as is practicable. To accomplish his purpose advantageously, it is requisite that the brewer or his architectural and mechanical agents, should well understand the natural law to which heat is subject, and the radiating power of the various metals which are suitable, and mechanically and chemically best adapted for the transmission and retention of heat.

Whatever may be the species of fuel consumed by a brewer, the heat resulting from its combustion, must be imparted to the liquor for mashing, &c. or to the wort for boiling through some intervening medium, and as the heat must pass through such medium to the liquor or wort, it is evident that the thinner the medium, the quicker and more abundant will be the quantity of heat transmitted, and it is therefore the brewer's interest to select that material which is the thinnest and the best radiator of heat, consistent with its cost and durability, and as no other material is found to combine all the requisite conditions so well as metal, the next consideration is, what species of metal shall be chosen and what shall be its thickness. In looking over the catalogue that a mechanician would most probably present to a brewer, of the species of metal that he would use for the formation of a boiler, we should most likely find enumerated, copper, plain and tinned sheet iron, and cast iron; and as the following several points of consideration would, or should present themselves to the brewer's notice—the radiating power, the tenuity, the durability, the first cost, and the ultimate value of each species of metal, when the boiler is no longer wanted, or fit for use, a few observations on the subject may serve to assist the uninformed.

It has before been stated, that the prompt, rapid and easy transition of heat through the intervening medium to the water or wort, is a matter of much consequence; and that the thinner the metal constituting that medium the better, consistent with its durability for a reasonable term; and of an adequate strength to sustain the weight of the fluid, and the pressure of steam to which it may occasionally be subject; and the first enquiry naturally induced is, which is the species of metal which will bear the greatest pressure at the least amount of thickness?

The objections that offer to cast iron are, first, the usual thickness, and therefore the tardy transmission of heat through it, and the loss of a great portion of the heat evolved from the burning fuel, from its incapability to pass through such metal with sufficient rapidity, and consequently its transmision and loss by the current of air which passes through and above the fuel to the chimney: next that as the metal is thick, it holds a large quantity of heat in its substance, and as a brewer has occasion frequently to discharge his boiler of its contents, should it be wort, that portion which adheres to the metal is liable to be burnt previous to its recharge, which not only causes a waste of such wort, but the impartation of an ill flavor to the succeeding wort; and should the recharge be cold water, then is there the liability of the boiler being split. The next objections are its great weight, and the very little value of the old metal, when it is either split or worn out.

The greatest objections to plain or tinned sheet iron, are its liability to oxidate, consequently its short duration, and its little value when worn out.

All the objections which have been enumerated to cast and plate iron, are inapplicable to copper; and against the several advantages which may be mentioned in its favour, its greater first cost appears to be the only set off.

The radiating power of metal vessels and pipes is another consideration to the brewer, to whom the retention or loss of heat is desirable; thus a metal mash tun, under backs, or fermenting tuns, (unless cased with wood) however advantageous they may prove as relates to cleanliness and durability, are by no means desirable as relates to radiation, as the imparted heat of infusion should not be lost from the mash tun, or the needed heat from the wort in the under back, to a greater extent than can possibly be avoided; and the same objections apply to metal pipes for the conveyance of the mashing liquor and of the wort to and from the under back, unless they are well coated with a non heat-conducting substance.

But a metal hop back, metal cooling backs, or refrigerator, are not only advantageous for their durability, but for the facility with which they radiate the heat from the wort which passes through them.

The objection to the use of plate iron on account of its liability to oxidate, appears to be obviated by the recent discovery of the method of zinc-tinning of sheet iron for the purpose of preventing its oxidation.

RANCID, ***strong scented, stinking.***

The meaning of the term rancid as applied to the brewery, is that state and condition of wort, beer, yeast, utensils and casks, as from which is emitted the compound fetor of acidity and putridity.

The cause of so pernicious a disease in the brewery, is the impartation of oxygen from the atmosphere to fluid wort or beer, and solid or fluid yeast, and to what may be termed solid wort or beer, adhering in a dry state to utensils or casks ; and the abstraction of carbon therefrom, causing the formation of an acetous and mephitic fluid or gas.

Raw wort is liable to rancidity from the impartation of too much oxygen to it from the atmosphere, in consequence of its too long and unnecessary exposure to it, during the process of extraction, and in consequence of such process not being conducted on right principles; deriving its acetous characteristics from such impartation, combined with the amount of gluten in excess, resulting from an error in the temperature of solution of the menstruum, and deriving its characteristics of putridity, from the combination of oxygen with the nitrogen of such gluten: and boiled wort is liable to be similarly affected from the same causes in its transit from the copper, through the various utensils to the cask of consumption; and escaping the disease in every previous stage, it may finally receive it in the cask in which it is sent out to the consumer.

Whatever vessel may have contained either unfermented or fermented wort, there will be an adhesion of a portion of it to the interior surface, and unless well washed off, it is subject to a chemical decomposition either in cold or hot weather, but in the latter much more rapidly.

The oxygen of the atmosphere combines with the carbon of such wort, induced by affinity and attraction, and carbonic acid gas is the result of the combination, which continues until the whole of the carbon is evolved, and then the oxygen combines with the hydrogen and nitrogen, the result of which is an acetic and mephitic compound, and which proves the acetous and putrefactive or rancid ferment to such wort, as may subsequently be placed in the vessel in which it is generated.

As prevention is better than cure, the greatest mechanical conveniences, promptitude of process, care, precaution and great cleanliness, are necessary to prevent the introduction of so injurious a malady into the brewery; and when it becomes an unavoidable and intrusive guest, chemical remedies must be resorted to for its expulsion.

RECTIFY, ***to make right, correct, redress, purify.***

In distillation, the term rectify implies the purification of spirit, by separating it from those substances, which imparted to the taste and smell an ill flavor, when it was in a state of admixture with them.

In the decomposition of grain by solution for the purpose of producing a fermentable fluid, several distinct substances of which grain is compounded, are dissolved and blended together in a state of chemical combination with the dissolving menstruum; and in the husk of all grain, particularly barley, there is a considerable quantity of fetid oil or resin, as is evidenced by the steep water, when withdrawn from barley, by which such oil or resin has been abstracted.

In the conversion of grain into malt, a great portion of such oil or resin is abstracted by the steep water in the cistern, and consequently it does not enter into the mash tun. But in the formation of wort for the production of spirit only, nearly the whole of the grist is usually composed of raw grain, and as such is not steeped previous to grinding or crushing for brewing, all the oil or resin which the husk possesses, enters into the mash tun, and is therefrom extracted by the mashing menstruum, and consequently forms a component part of the wort or wash.

The wort or wash thus procured is subsequently subjected to a very powerful vinous fermentation; and as the purpose is to create as much spirit as is possible, the vinous fermentation is generally carried to the verge, and frequently beyond the limits of the vinous, into the acetous stage, and consequently such wort or wash often contains a considerable quantity of acetous acid.

A distiller's wort or wash is also subject to all the liabilities of an acetous and putrefactive fermentation in conjunction with the vinous, from the same causes as is the brewer's wort.

A distiller's fermented wort or wash is then at all times a compound of spirit, water, unfermented extract, and fetid oil or resin, and often comprises acetous acid, and a mephitic substance. But whatever it may be, he places it in the still with a view to separate the spirit from it, and he is desirous of effecting such purpose completely, or as nearly so as is possible.

The temperature of evaporation or boiling heat of spirit, is lower than that of water; water lower than acetous acid, and acid lower than oil; and if these substances occupied the still in strata, in the order above described, the oil being at the bottom, and the spirit at the top, there would be no difficulty in separating the spirit from the rest, and all that it would be necessary to do, would be to transmit heat through the several strata to the spirit, until it had attained to the evaporating temperature, and to continue such impartation with that regularity and precision, as would not raise the water to the boiling heat previous to the disengagement and separation of the whole of the spirit. But the spirit is intimately blended with the other substances and diffused throughout the whole mass, and as the heat imparted to the wash in the still ascends to the upper surface, and the temperature of the upper surface attains to the evaporating heat of spirit, before the bottom and intervening bulk of wash possibly can do, and as but a very small proportion of the total quantity of spirit which the wash possesses is diffused throughout the upper surface, so a very small portion of spirit in vapour can ascend, on the attainment of the upper surface of the wash to the evaporating heat of spirit; and the consequence is, that as the impartation of heat must be continued, in order to convert the residue of the spirit below the upper surface into vapour; and as such spirit must first rise to the upper surface before it can be converted into vapour, so the other substances which are upon the upper surface, are liable to, and do attain to their respective temperatures of evaporation, and by the time the succeeding portions of spirit are successively raised to the upper surface, the other substances are converted into vapour also and rise in conjunction with the spirit, and hence the cause of the impurity of the spirit which is brought over the helm and condensed in the worm, and the impurity of the latter portions which are brought over. To illustrate this exposition more clearly, it may be necessary for us to state that the atoms of heat which are liberated from the fuel in combustion in the furnace of the still, obey the double law to which they are subject—recession from the earth and equal diffusion. Advantage is taken by the knowledge of this law, and the still is placed immediately over the burning fuel, and the diameter of its bottom is made as great as it consistently can be in proportion to its contents. The heat thus liberated passes through the bottom of the still and enters into the wash, and obeying the law of recession from the earth, it instantly ascends to the upper surface of the wash; and if the air above the upper surface of the wash is as hot or hotter than the wash, the heat which has ascended to the upper surface will then remain, and will soon be joined by succeeding atoms of heat, until enough is collected together as is sufficient to raise the temperature of the blended substances diffused throughout such surface, to the evaporating temperature of the spirit, and then, and not till then, will the heat collected at such surface leave it, except such portion as has necessarily left it to pass into the superincumbent air, to raise it to the temperature of the upper surface of the wash. It may be necessary here to observe, that if atoms of heat transmitted from the burning fuel to the wash, obeyed but one law—that of equal diffusion, such as were first imparted would remain at the bottom of the still until the addition of more, when the insertion of the latter would force the former upward, and thus the temperature of the wash would be greatest at the bottom, and the temperature of the whole mass would not be equal until the first atoms of heat had been forced up to the upper surface; but as it obeys both laws, the first portion of the atoms of heat imparted to the wash immediately ascend to its upper surface, and the accumulation proceeds from the top and gradually descending, instead of from the bottom and gradually ascending; and indeed were both laws not obeyed, the process of evaporation could not be effected, as the accumulation of heat at the bottom surface would soon equal the quantity emitted from the burning fuel, and the transition would cease before evaporation could commence.

It will be obvious from what has been already stated, that for the economy of fuel, and the obtainment of spirit as free from impurity as possible, that the diameter of the bottom of the still should be great, and the depth shallow, inasmuch as the greater the recipient surface of the still to a perpendicular transmission of heat, the less will be the loss of such as is evolved from the burning fuel; and the greater the extent of the upper surface of the wash, the greater will be the proportion of spirit converted into vapour by the first impartation of a sufficiency of heat; and the less the depth, the more rapidly and with the greater facility will each succeeding portion of spirit be raised to the upper surface, and converted into vapour, and consequently the smaller will be the amount of the other substances, which will be carried over the helm in conjunction with the spirituous vapours.

Having clearly shown we trust, the cause of the impurity of spirit drawn from a distiller's wash, as relates to its admixture with impure substances which partly composes such wash, and its diffusion throughout the bulk, and the impossibility of separating it in the form of vapour from those substances, previous to their conversion into vapour, to an extent proportionate to the area of the upper surface of the wash and its depth, and the degree of rapidity of the impartation of heat; we have next to enquire, if a separation of the alcoholic vapour from the other vapours, cannot be effected, subsequent to their ascension from the wash together, and previous to their condensation in the worm. Happily for such modern distillers and rectifiers as have and may avail themselves of the discoveries of scientific men, an expedient has been devised, of separating the alcoholic from the other vapours to an extent approximating to perfection, founded on the knowledge of the inequality of the evaporating temperatures of spirit, and the other substances with which it is blended in the wash.

The boiling or evaporating temperature of spirit is about 176 degrees, and water about 212 degrees; and on the supposition that it is accurately so, it is evident that if spirit is in a fluid state at 175 degrees, and water at 211 degrees, and the addition of one degree more of heat to each is sufficient to convert them into a state of vapour, so when in a state of vapour, if one degree of heat is abstracted from either, they will be again converted into a fluid state.

Now let us mentally view a common crane neck still, and imagine that we see ascending from the surface of the wash, alcoholic, aqueous and other vapours intermixed, and we find no impediment to their passing together over the neck, and reaching that part of the worm where condensation commences; the alcoholic vapour is first condensed, the aqueous next, and the rest in the order of succession as per their evaporating temperatures, and the whole being condensed previous to their reaching the receiver, they enter it together in a fluid state. Let us further imagine, that some substance is suspended between the wash in the still and the helm, whose temperature is at any intermediate heat between 176 and 212 degrees, but the nearer 176 degrees the better, and that its temperature can be kept at some intermediate point between, during the whole process of distillation, and all the vapours that ascend from the wash, must first come in contact with this substance, previous to their reaching the helm, it is obvious that such substance being of a higher temperature than the alcoholic vapour, cannot abstract heat from it, and therefore cannot condense it or convert it into a fluid, and consequently must pass by such substance, attain to the helm and pass over. But as such substance is of a lower temperature than the aqueous and other vapours, it is also evident that it must abstract heat from them, and consequently condense or convert them into a state of fluidity, and in such state they must be precipitated back to the wash in the body of the still. This principle of separation of the alcoholic from the aqueous and other vapours has led to the ingenious contrivance of several stills varying in modification; and among others we have furnished a still which effects two distillations in one operation; is supplied with two condensing baths; which produces spirit of great strength and purity from a weak wash; which cannot run foul, burst nor collapse; which requires no worm and worm tub, and a very small amount of water for the purpose of condensation, and nearly the whole of which water is raised in temperature to about 176 degrees, and may be applied to the various uses of the distillery or rectifying house; or the condensation may be effected by wash, which being raised to such a temperature without any loss of spirit, may serve as a charge for another or the same still, so as to effect a considerable saving in fuel and in time. (For further particulars relative to this still, see the article "Still").

By the use of our still, and most probably by other improved stills, a marketable spirit of sufficient purity and strength, might be furnished from distillers' wash at one distillation; but by the crane neck and other common stills, the produce of the first distillation is not of marketable strength and purity, and is technically called "low wines," and which is subjected to another distillation, whereby its strength and purity is improved, and in such state it is technically called raw spirit, and is sold to the rectifier, whose province it is to render it yet more pure, and to manufacture the various compounds which his customers require.

The raw spirit thus purchased by the rectifier, is still blended with fetid oil and acetous acid, and it is the rectifier's business to impart to it such chemical ingredients, as he deems necessary and sufficient to combine with such oil and acid to neutralize their properties; and by distillation to separate the spirit from its impure associate substances, as well as their chemical and mechanical knowledge and capabilities will enable; and the produce is called rectified spirit. The chemical ingredients commonly used for such purpose, we consider unnecessarily expensive, because we have discovered those which are much less costly, and we conceive more effective.

In this first distillation by the rectifier, the first portion which comes over from the still is called "foreshot," and is very impure, being blended with the volatile portion of the rectifying ingredients, and such produce is run off into the faints receiver.

When the foreshot is all off, the spirit which is called pure is conveyed to the spirit receiver, and continues to run therein until what is termed the faints comes over, and such produce is run off into the faints receiver.

The latter product of spirit termed faints is very impure, and is obtained by carrying on the process of distillation until the whole of the spirit is brought over, and which spirit being blended and diffused among such impurities, cannot be brought over by the common still, without a portion of those impurities with it, and we claim as a strong feature of merit in our still, that its produce of faints is very small, and much purer and stronger than is the produce of common stills.

The faints are appropriated by one or more subsequent distillations, to the production of spirit of wine of various degrees of purity, and some compounds, the flavor of whose ingredients are sufficient to cover those impurities which would be perceptible in it as an uncompounded spirit.

The manufacturers of british brandy select the purest rectified spirit for the purpose, and flavor and color it in various ways; and under this head we claim the discovery of a very superior flavoring ingredient, imparting to pure british spirit, a flavor closely approximating to such as is so justly appreciated and approved in french brandies of the finest quality.

The various compounds of the rectifier, are either the produce of a distillation from rectified spirit, and the several ingredients which are mixed with it in the body of the still, or which are placed in a separate compartment of the still, and the flavor therefrom derived by the alcoholic vapour instead of the fluid spirit; and our still furnishes the means, of either inserting the flavoring ingredients into the body of the still with the fluid spirit, or into a compartment in which the alcoholic vapour of the first distillation is condensed and converted into a fluid, and which spirit being stronger and purer than that which is in the body, and in which the ingredients are not subject to so long a decoction, a purer flavor therefrom is thereby obtained.

For our rectifying ingredients and still we claim the further advantages, that those ingredients which may be added to the raw spirit in the cask, and therein deprived of its fetor and acid; that such spirit may be drawn from the cask, clean from those ingredients, and put into the body of the still, without the need of any further addition within the still; that the ingredients left at the bottom of the raw spirit cask may safely and advantageously be put into the faint vat, in order to prevent the loss of spirit which they hold in combination, and that the flavoring ingredients for gin or any other compound, may be put into the vapour compartment of the still, and gin or other compounds produced at one distillation, equal in quality to such as is usually produced by two distillations.

REFRIGERATE, *to cool, allay, refresh.*

To refrigerate or cool a substance is not an impartive but an abstractive act.

The term cold is a negative and not a positive appellation, and is used to denote the absence of heat, and not the presence of a principle or property.

To refrigerate or cool a substance, nothing more is necessary, than to place it in contact, or in the vicinity of some other substance which possesses less heat, and by the law of equal diffusion, as much heat will leave the hottest body and enter into the coldest, as will render both of an equal temperature.

Although the equal diffusion of free and active heat invariably occurs, when time and circumstances favor the transfer, yet to the superficial observer, the doctrine of the equable diffusion of heat may appear to be contradictory in innumerable instances, and he may adduce as an example, that his own body placed in atmospheric air or water of much lower temperature, is never reduced to an equality with it; but such an observer cannot be acquainted with the fact that the supply of heat to his body is equal (in ordinary circumstances) to the abstraction; and that as much heat as is abstracted from his body, and gradually diffused throughout the air or water which surrounds him, is supplied to his body from the atmosphere, by its decomposition within the lungs.

Many substances differ materially in their capacity for the reception and transmission of heat, and as a medium for the purpose of refrigeration, due attention should be paid in the selection, to their retentive and transmissive capacities.

Air and water are the most suitable elements for the purpose of refrigeration, as relates to the facility and economy of obtainment and application.

Air is not a good conductor of heat, and as water is, it is the preferable medium for the abstraction of heat as relates to its effective promptitude.

If air is used as the medium for the abstraction of heat from wort, without the intervention of any other substance, and being in close contact with it, it is evident that the abstraction is facilitated, by exposing as large a surface as is possible to the recipient atmosphere ; but it must be remembered that the atmosphere is not only a recipient medium of heat, but an impartive medium of oxygen also, and that it possesses a variable quantity of oxygen combined with it in a state of simple mixture, and sometimes not more than it is advantageous that the wort should imbibe during its exposure to it; yet at other times it possesses much more than is sufficient, and generally at such a time also, as its high temperature and quiescent state render it less effective as a heat abstracting medium, and consequently the wort is subject to an injurious absorption of oxygen, resulting from its presence in abundance in the atmosphere, and the long exposure of the wort to it.

Wort exposed in shallow cooling backs to the action of the atmosphere, as an abstracting medium of its heat, is refrigerated with a promptitude proportionate to the amount of difference in the temperature of each, and the quantity of air which passes over the wort.

In addition to the loss of time that results from the cooling of wort by its exposure to the atmosphere in shallow cooling backs, and its frequent absorption of too much oxygen, may be calculated the loss of wort by adhesion to their surface, which by computation is found to be half a gallon per barrel, constituting a loss of nearly one and a half per cent. each brewing, of the last wort which covers them, at the depth of 2½inches.

An indefinite and most absurd notion exists in the minds of many, that an exposure of wort to the atmosphere, is necessary to abstract some principle or other (but what principle they do not know) beside heat, and we have heard an opinion ventured, that it may be fixed air. But we have always been taught, that by the boiling of wort, the air is expelled from it, and the apellation "fixed air," implies any thing but the idea of its abstraction, by the exposure of wort containing it to the atmosphere. And if by the term "fixed air," is meant carbonic acid gas, we can very confidently assure our readers, that neither raw or boiled wort contains any carbonic acid gas previous to fermentation; and if wort is continued under such injurious circumstances, or for such a period in the cooling backs, as to allow of the formation of carbonic acid gas by fermentation therein, we wish the unfortunate owners much better success with their product than we expect they will ever meet with. But the fact is, that wort exposed to the atmosphere in the cooling backs under favorable circumstances, imparts nothing to it but heat, aqueous vapour and aroma, (the latter of which had better not be lost) and it can receive nothing from the atmosphere (chemically) but oxygen, a sufficiency of which it needs, and a redundance of which is injurious.

Those who have paid attention to the subject, will not have failed to notice, that raw wort which runs perfectly transparent from the mash tun into the under back, will very soon become opaque, and that such opacity is removed by the process of boiling; that such wort will flow from the copper into the hop back again brilliant, but after laying some time exposed to the air in the cooling backs, it will again become opaque, and such opacity is no more removed until fermentation has ceased, and transparency results from depuration naturally or by the aid of finings. The cause of the opacity to wort in the under back and cooling backs, is the impartation of oxygen from the atmosphere, and the impartation of a sufficiency of oxygen to raw wort, so as to tarnish its brilliancy, proves more or less injurious to such wort; as previous to the process of boiling, wort needs not the absorption of oxygen to cause fermentation. And again, the absorption of a sufficiency of oxygen, so as to tarnish the brilliancy of wort in the cooling backs, is injurious, inasmuch as the period of time which occurs between the pitching of the tun, and the biting of the yeast, (as it is technically termed) is quite sufficient for the absorption of as much oxygen as is needed at any time of the year, when its presence in the atmosphere is the least abundant; and all that is imbibed beyond such a sufficiency is positively injurious, and particularly so in warm weather, when oxygen is abundantly diffused throughout the atmosphere, and the absorption of too much by the wort, causes the premature and irregular combination of it, with the atoms of which the wort is composed, and thereby causes a fermentation too rapid, too extensive and injuriously irregular in the formation of the several products. And such theoretical views we have found well supported by practical observations, having often in our early practice, experienced the evils resulting from the absorption of too much oxygen by both raw and boiled worts, and experiencing in our present practice, by a prompt system of extraction and refrigeration, an avoidance of such evils; and it forms part of our present practical system, to cause the transition of wort through its various stages to the fermenting tun, with its brilliancy untarnished. And as relates to the operation of refrigeration, as an indispensable auxiliary to effect so desirable a purpose, our system comprises the transition of the wort from the hop back, through the refrigerator into the fermenting tun, commencing the process in about a quarter of an hour, after the exit of the wort from the copper; and in every instance we have found, that wort thus refrigerated will enter into the tun perfectly transparent, a good fermentation will ensue, (all other circumstances and arrangements favorably concurring) and the product prove a sounder, better keeping, and better conditioned beer, than from such wort as has been unnecessarily exposed for too long a period in the cooling backs.

The superior advantages resulting from the use of water as a refrigerating medium, above that of the atmosphere are several; the process can be effected with greater promptitude, with more certainty and precision, with a greater abstraction of heat at any time, and particularly at such time when a low pitching temperature is most desirable; with less loss of wort by adhesion; without chemical injury resulting from abstraction or impartation; without the necessity for cooling backs, the building that contains them, the labour to clean them, the liabilities resulting from ærial impartations and uncleanliness; by the impartation of heat to the water employed in its abstraction, and the consequent saving of fuel; by the improvement in the quality of such water as is bad or indifferent, connected with other means to effect the object; by the superior adaptation of such water for the purposes of brewing, raised very considerably in temperature without the cost of fuel or time, and elevated to the required position without waste, extra labour, or sacrifice of time.

REFRIGERATOR, *an apparatus or machine for the purpose of abstracting heat from gases, fluids or solids.*

Having endeavoured to prove the superiority of water to air as a refrigerating medium or agent in our preceding subject, it now devolves upon us to exemplify the principles upon which a refrigerator should be constructed, so as to render the smallest quantity of water sufficiently effective; so as to raise it to a sufficient height for subsequent appropriation; so as to reduce the wort in temperature to any point with ease and precision; and so as to render the use of cooling backs unnecessary, and prevent the chemical injury derived by too extensive and long exposure of wort to the atmosphere.

As the abstraction of heat from wort must be through some intervening medium, such medium should be a good conductor of heat, and as thin as possible consistent with the strength which is necessary to sustain the resulting pressure; and therefore in selecting such medium, its tenuity should be considered, and the form of structure as relates to the greatest capability of sustaining pressure; and the choice is naturally directed to copper, formed into cylindrical pipe, as possessing and yielding the requisite qualities and capabilities, and of the greatest ultimate value, as relates to metallic worth and general appropriation.

To facilitate the abstraction of heat from wort, and to effect it with the least possible quantity of water, as great an extension of surface should be given to both the wort and water as is possible, consistent with other considerations which require due attention; and as the transition of heat is not instantaneous but gradual, and the greater the distance which heat has to travel, and the thicker the medium through which it has to pass, so must be the period of continuance of the abstractive process, commensurate with the work to be performed, and the impediments that retard its performance. Thus if a one inch pipe is enclosed in a two inch pipe, and the inch pipe is filled with hot wort, and the two inch pipe is filled with cold water, and on the supposition that the heat radiates equally in every direction, and in the order of position in which the atoms of heat may be supposed to be placed in the wort, then will every atom have to travel the distance of half an inch from the wort into the water, before an equality of temperature can occur; and if a half inch pipe is enclosed in a one inch pipe, and filled with wort as before, each atom of heat has then only a quarter of an inch to travel; and again as the pressure upon a one inch pipe filled is greater than upon a half inch, it is necessary that the thickness of the metal should be greater to sustain the additional pressure; and thus the one inch pipe presents twice the distance for the heat to travel, and through a thicker medium than does the half inch. In addition to those two important points of difference—the greater distance which the heat has to travel, and the greater thickness of metal through which it has to pass from the wort to the water, may be mentioned a third material consideration, connected with the relative contents of the two pipes—the one inch pipe containing four times as much wort as the half inch, and consequently a quadruple amount of heat. A fourth point of consideration is the fact, that the circumference of a one inch pipe is but double the circumference of a half inch pipe, and consequently the radiating surface for the transmission of heat presented by the one inch pipe, is but twice as great as is presented by the half inch pipe; and therefore in taking a review of the comparative capabilities of pipes of the two mentioned diameters, as a medium for the transmission of heat from wort to water, we find the case stands thus; four times the amount of heat to be abstracted from the one inch pipe than from the half inch; twice the distance the heat has to travel; metal of much greater thickness to pass through, and but twice the radiating surface. And if we compare the relative capabilities of a two inch pipe and a half inch pipe as a refrigerating medium, upon the same principle as we have furnished a comparative statement between a one inch and a half inch pipe, we shall find the case as follows: the content of a two inch pipe being sixteen times as great as the content of a half inch, there must be sixteen times as much heat to be abstracted from its contents; four times the distance for the heat to travel; a still greater thickness of metal for the heat to pass through, and four times as great a radiating surface. Thus as a refrigerator, constructed of a half inch pipe enclosed within a one inch pipe, produces more than a double refrigerative effect to what an inch pipe enclosed within a two inch pipe will furnish, so more than a quadruple effect will result from its appropriation, than will from the enclosure of a two inch pipe within a four inch; and the greater the extent of diameter of the pipe employed, the greater will be the comparative ratio of the extent of the difference in effect produced.

A quarter of an inch pipe enclosed within a half inch pipe, would, by parity of reasoning, prove much more advantageous than a half inch within an inch pipe; but the greater amount of friction to which the wort would be subject in passing through, and the greater difficulty in cleansing pipes of such small diameter, would render their use for the cooling of wort objectionable.

Having determined the convenient minimum diameter of the pipes, through which the wort to be cooled, or the water to cool should pass, the next subject of consideration is, the most effectual and economical arrangement of the half inch pipes in the construction of a refrigerator.

The area of a half inch pipe is, .0007, the area of an inch pipe is .0028, and the area of a two inch pipe is .0133, and it will be found that five half inch pipes, can be conveniently inserted in a two inch pipe at uniform distances apart, leaving sufficient room for water to flow all round them; and if we multiply .0007 by 5, we shall find the united areas, .0005. The area of a two inch pipe is .0113, from which if we abstract .0035, leaves .0078, the space for the water, which is rather more than double the space occupied by the wort; but we have a yet further abstraction to make from the .0078, for the space occupied by the metal of which the half inch pipes are made, and on the supposition that such is equal to .0008, we then have left .0070, the space for the water, which is just double the space occupied by the wort. By the insertion then of five half inch pipes within a two inch pipe, instead of a one inch pipe within a two inch, we find that we have a radiating surface of about seven and a half inches instead of about three, the circumference of a half inch pipe being about one and a half inch, which multiplied by five, is seven and a half inches, and the circumference of a one inch pipe is about three inches. In addition to this much greater amount of radiating surface, resulting from such arrangement, the heat has but a moiety of the distance to travel, and there are five central sources of diffusion of heat instead of one, facilitating the transition with proportionate rapidity.

In taking a review of the important advantages resulting from the insertion of five half inch pipes into a two inch, instead of a one inch pipe within a two inch pipe, for the purpose of abstracting heat from wort by water; we must not forget to notice, that the advantages increase, in the ratio of the increase in the diameter of the external pipes, and in the number of half inch pipes; thus if we insert seven half inch pipes, in a two and a half inch pipe, we obtain a radiating surface of ten and a half inches against three and three quarters. But the following illustrative tabular view of the construction of refrigerators of our invention, consisting of half inch pipes inserted in one pipe of nine several diameters, in juxta position with the insertion of one pipe only, in another pipe of corresponding diameter, the internal pipe being a moiety in diameter of the external pipe; will not only shew the difference, but the increasing difference in the radiating surface of each, in proportion to the increase in the diameter of the external pipe.

Diameter of external pipe.	Number of internal pipes inserted.	Diameter of internal pipes inserted.	Circumference (about) or radiating surface of internal pipes.
2 inches	5 pipes	½ an inch	7½ inches
2 ditto	1 ditto	1 ditto	3 ditto
2½ inches	7 pipes	½ an inch	10½ inches
2½ ditto	1 ditto	1¼ ditto	3¾ ditto
3 inches	9 pipes	½ an inch	13½ inches
3 ditto	1 ditto	1½ ditto	4½ ditto
3½ inches	11 pipes	½ an inch	16½ inches
3½ ditto	1 ditto	1¾ ditto	5¼ ditto
4 inches	14 pipes	½ an inch	21 inches
4 ditto	1 ditto	2 ditto	6 ditto
5 inches	19 pipes	½ an inch	28½ inches
5 ditto	1 ditto	2½ ditto	7½ ditto
5½ inches	22 pipes	½ an inch	33 inches
5½ ditto	1 ditto	2¾ ditto	8¼ ditto
6 inches	28 pipes	½ an inch	42 inches
6 ditto	1 ditto	3 ditto	9 ditto
7 inches	38 pipes	½ an inch	57 inches
7 ditto	1 ditto	3½ ditto	10½ ditto

Having endeavoured to prove the superiority of copper as a metal for a refrigerator; cylindrical pipe as to form; half inch pipe as to diameter; the insertion of several in one of larger diameter as to construction; and the larger the diameter of the external pipe, the greater may be the proportionate number of the internal half inch pipes, and consequently the proportionate increase of the radiating surface for heat; we will next proceed to shew, that the operation of cooling wort by water, may be divided into four several principles, and effected with apparatus that will admit of a variety of modifications.

First—Running wort passing through quiescent water.

Second—Running water passing through quiescent wort.

Third—Running wort or water, passing through running water or wort, both wort and water, or water and wort, running in the same direction.

Fourth—Running wort or water, passing through running water or wort, both wort and water, or water and wort running in opposite directions.

As relates to either method, of course it must be understood, that some intervening substance keeps the wort and water from a state of union; and through such intervening medium, the heat of the wort is transmitted to the water.

The objections to the first principle are, that from the quiescent state of the water, the abstraction of heat is not so much facilitated, as if both wort and water were in a state of motion, the change of the surface of water not being so rapid and frequent, as the result of the change of its specific gravity by the impartation of heat, as to render it fully effective as an abstractive medium; and also because the wort must travel exceedingly slow, or travel a very great distance through the water, in order to allow sufficient time for the abstraction of its heat; and again the quantity of water must be very great in proportion to the quantity of wort, in order to reduce the temperature of the wort to the pitching heat, as may be exemplified by the following suppositious case. To cool one barrel of running wort at 180 degrees of heat down to 60 degrees, how many barrels of quiescent water at 50 degrees will be necessary for the purpose? Answer, 12 barrels.

The objections to the second principle are precisely the same as the first, and the same quantity of water which is required to cool one barrel of wort is the same in both cases.

The objections to the third principle are, that the wort and water must either run very slowly together, or run together a very great distance before the unequal quantity of heat in the wort can be diffused to a point of equality throughout the bulk of water; and on the supposition that in this case, the temperature of the wort is 180 degrees, and which is to be cooled down to 60 degrees, by water at 50 degrees, then the quantity of water running in the same direction with the wort must be as twelve barrels to one, and both must continue to run together until an equality of temperature is attained; which will be exemplified by multiplying 12 barrels of water by 50 degrees of heat, adding thereto the heat of one barrel of wort at 180 degrees, dividing the product by 13 barrels, and the quotient will be 60 degrees, the mean temperature both of the wort and water.

The fourth principle appears to us to be the only one free from objections, and that every refrigerator, the construction of which is not based on such a principle, is decidedly deficient in effective power, and must require either a much larger quantity of water to reduce the wort from a high temperature to a low one, or the wort must first be very considerably reduced in temperature by the atmosphere, (and thereby incur the consequent evils) and be finished off by a moderate quantity of water.

But to perceive the merits of the fourth principle, some explanatory observations may be necessary, and we will endeavour to place the whole in juxta position, and leave our readers to judge for themselves.

Mix intimately and without medium, 12 barrels of water at 50 degrees, with one barrel of wort at 180 degrees, and the mean temperature of the whole by calculation will be 60 degrees.

Enclose one barrel of wort at 180 degrees of heat in a pipe, and immerse it in 12 barrels of water at 50 degrees, allow it to continue until the temperature of the wort is reduced to 60 degrees, and it will be found that a considerable time must elapse before such an effect will be produced; and the time will be proportionate to the length of the pipe, and the arranged proportion of the surrounding water.

To pass such wort either slowly or rapidly through such pipe, (illustrative of the first principle) instead of allowing it to remain stationary, until transition of heat to a point of equality has occurred, will cause a defalcation in the desired purpose, proportionate to the rapidity of the progress of the wort, and clearly demonstrate a well known axiom, that "what is gained in speed is lost in power," and that 12 barrels of water at 50 degrees, will not be sufficient to cool one barrel of wort at 180 degrees down to 60 degrees, let it run ever so slow.

Reverse the material, (and thereby illustrate the second principle) and the same observations will also apply.

Enclose one pipe within another, the diameter of each being such, that in the same length, the inner pipe shall contain one barrel of wort at 180 degrees, and the external pipe 12 barrels of water at 50 degrees, exclusive of the inner pipe and its contents, and let the wort and water run in one direction and at the same speed (and thereby illustrate the third principle) a sufficient length of time, until transition of heat to a state of equality has occurred, and the wort makes its exit at 60 degrees of heat, and it will be found that the length of such pipes must be very great, and proportionate to the speed at which both wort and water run.

To illustrate the fourth principle, let us imagine a pipe of such diameter, as that one foot in length, shall contain one gallon of wort, enclosed in a pipe of as much larger diameter, as that every foot in length of such external pipe, shall, in addition to the internal pipe, contain two gallons of water; let us further suppose the length of each pipe to be the same, and sixty feet, and that the wort is caused to run in one direction, and the water in the other, and that in passing through every foot of such pipes, the wort loses two degrees of heat, and the water one: it will then appear evident, on reference to the annexed diagram, that the wort will enter at one end of the interior pipe at 180 degrees of heat, and leave the other at 60 degrees; while the water will enter at the opposite end of the external pipe at 50 degrees, and leave the other end at 110 degrees of heat.

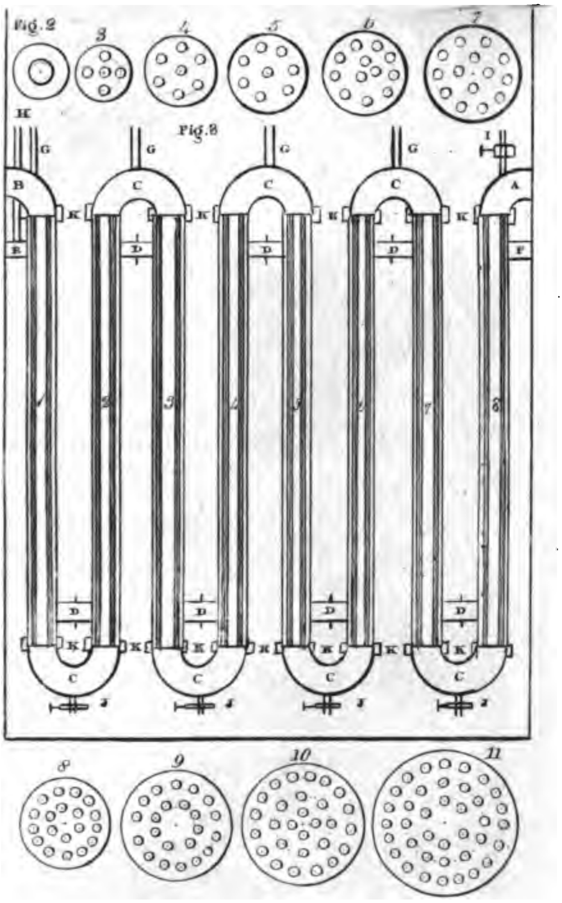
But the suppositious case which we have submitted, that one measure of wort running through one pipe enclosed in another pipe containing two measures of water in the same length, may be cooled from 180 to 60 degrees, by water at 50 degrees, in a length of 60ft. will not hold good in practice, however well it may serve the purpose of illustration; and hence to accomplish the object with the same length of pipe, and the same proportion of water to wort as mentioned, it is necessary to insert in the external pipe, as many internal pipes instead of one, as is sufficient to accomplish the purpose.

Having demonstrated the several principles on which all refrigerators to cool wort by water are constructed, and that the fourth principle referred to, is the most efficacious and economical; we have next to request the attention of our readers to a refrigerator of our invention, constructed on the fourth principle, with external copper pipes of any diameter, not less than two inches, with as many half inch copper pipes inserted as is suitable to each size; and we refer our readers to the annexed sectional view of it, and the diagram, Fig. 3, 4, 5, 6, 7, 8, 9, 10, 11. Fig. 3, being a two inch pipe containing 5 half inch pipes. Fig. 4, a two and a half inch containing 7 half inch pipes. Fig. 5, a three inch pipe containing 9 half inch pipes. Fig. 6, a three and a half inch pipe containing 11 half inch pipes. Fig. 7, a four inch pipe containing 14 half inch pipes. Fig. 8, a five inch pipe containing 19 half inch pipes. Fig. 9, a five and a half inch pipe containing 22 half inch pipes. Fig. 10, a six inch pipe containing 28 half inch pipes. Fig. 11, a seven inch pipe containing 38 half inch pipes.

51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71

72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	132	134	136	138	140	142
72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92

93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
144	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178
93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110



Refrigerator.

On reference to the annexed sketch of this refrigerator, it will be perceived, that it consists of a series of eight external pipes, but the number, length, and diameter of the external pipes, may be varied to suit the localities of situation, and the quantity of wort required to be cooled, within any given period of time, and which pipes are connected together at the ends by semicircular pipes, and straight pipes at the sides, the whole united by union screws; the wort traversing the half inch pipes throughout each case, and flowing into the half inch pipes in the succeeding case by the semicircular connecting pipe, and the water traversing within each external pipe, flowing freely round every half inch pipe, and finding its way from one case to another, by the cross connecting pipes; the wort running in one direction and the water in the opposite. The requisite cocks for drawing off the wort or water will also be perceived, with the necessary air pipes, &c.

This refrigerator may be fixed in a vertical, horizontal, or longitudinal position, and may be adapted to almost every conceiveable position below the hop or cooling backs, and also below the fermenting tuns, if requisite, as the wort with which it remains charged, after all is run from the hop or cooling back, is driven out with water, superseding the necessity of drawing it off by the cocks; but it is requisite that the manufacturer should be informed of the position in which it is necessary to fix it.

When an ample choice of situations offer in which to fix it, we prefer attaching it to a wood frame in a vertical position against a wall, where it may occupy a place not available to or needed for any other purpose, and in such situation or position, it usually occupies a space against the wall of from 8 to 9ft. by 10 to 12ft. projecting from it, not more than a foot.

The weight from the smallest to the largest size mentioned is from 150 to 1000 pounds; the cost varying with the price of copper, within the limits of from about £40 to £260, exclusive of the cost of fixing in the intended situation, and the necessary connexions.

The average quantity of wort which may be cooled by each per hour is from 8 to 60 barrels, requiring an average quantity of two barrels of water to cool one barrel of wort.

It may be opened and separated by any common workman for cleansing, which will not require to be performed oftener than once a year, and it may be cleansed with great facility, and at a trifling cost. The refrigerator of Messrs. Wigney's was fixed in May 1836, was cleaned the first time on the 13th of January 1837, and the second time on the 4th of April 1838, and then did not really need cleansing.

In the state of separation and package, the dimensions of the case for the largest size need not exceed in length about 12ft. width about 4ft. and depth about 2ft.

All the internal surfaces of the wort pipes are tinned, all the water used in cooling the wort, may be pumped from the well into the liquor back through the refrigerator, which will serve as a tortuous rising main, occasioning no extra labour; or it may be supplied by water from any other source.

By commencing the refrigeration of wort from the hop back in about a quarter of an hour after its exit from the copper, and at 195 degrees of heat, we have found the water used for the purpose, ascend into the liquor back at 130 degrees; and this inexpensive mode of imparting heat to water, in addition to the improvement of its quality for the purpose of brewing, forms a prominent feature in the many advantages which this refrigerator furnishes.

The quantity of wort which may be cooled per hour, and the proportionate quantity of water that is required to cool any given quantity of wort, by one of our refrigerators of any given size, is subject to so many variations arising from peculiar circumstances and local causes, that no accurate statement can possibly be furnished; but as a guide to the judgment, we can state that a refrigerator consisting of eight cases, or external pipes, of a diameter of five inches each, length of half inch pipes eight feet six inches, each containing nineteen half inch pipes, fitted up in the brewery of Messrs. Wigney's of Brighton, under our superintendance and directions, and the performances of which we attentively observed at intervals during a period of eight months, cooled 2681 barrels of wort of every description, varying in density from 9lbs. to 41lbs. per barrel, in heat, from the cooling backs and hop back, varying from 80 to 195 degrees, down to from 61 to 73 degrees of heat in the fermenting tun, in 94 hours 10 minutes, with 5664 barrels of water, the temperature of which in the well varied from 52½ to 54 degrees, being an average of about 28½ barrels of wort per hour, cooled with water at an average of 2 1-10th barrels to one barrel of wort.

The following is an analytical tabular statement of the average results of the performance of Messrs. Wigney's refrigerator before referred to, as per statement contained in my circular addressed to brewers in the year 1837.

Description of wort cooled.	Number of barrels of wort cooled.	Time occupied in cooling wort.	Number of barrels of water used in cooling.	Average number of barrels of wort cooled per hour.	Average number of barrels of water used to cool one barrel of wort.
XX Ale	1516½	3548 min.	3548	25. 6 tnths	2. 3 tnths
Dbl. Stout	301¾	553 do.	553	32. 6 tnths	1. 8 tnths
Single do.	108½	197 do.	197	32. 9 tnths	1. 8 tnths
Tbl. Beer	754¼	1352 do.	1366	33. 4 tnths	1. 8 tnths
	2681	5650	5664		

It will appear by the preceding statement that the supply of water by computation founded upon observation, was about one barrel of water per minute; and as such refrigerator is capable of bearing the pressure of a much greater quantity of water by transmission through it, in the same period of time, the above statement does not therefore furnish the full capabilities of the refrigerator, but of its performance in the ratio of the quantity supplied; and from the several data furnished, any brewer may form an opinion, of the probable effective capabilities of one upon his own premises, by informing himself of the comparative analogy of his own resources to operate with it.

The temperature of the wort passing into the fermenting tun, may be adjusted to any required point for pitching, with the greatest facility and accuracy.

The testimonials contained in the following certificates will, we trust, be quite sufficient to satisfy the mind of every one, of the several merits of the refrigerator, the particulars of which we have submitted to the reader's attention; and prompt those who are in need of so useful an apparatus, to favor us with their orders, or the present manufacturers, Messrs. Williams and Yearsley, of Brighton.

CERTIFICATES.

(Copy.) Epsom, Nov. 25, 1835.

Sir,—In compliance with your request, we give you our opinion of the merits of the refrigerator, put up by Messrs. Williams and Co. which you state to be of your invention. We have used the said refrigerator for above six years, and have found it in operation very effectual, economical, and to us quite satisfactory; and the cost of repairs has been comparatively nothing, and we have never seen one on any other principle that we should like so well.

To Mr. G. A. Wigney, We are, Sir, your obedient Servants,
Brewer, 21, Ship St. Brighton. (Signed) T. & S. PAGDEN.

(Copy.) Brighton, Nov. 27, 1835.

Having within the last twelve years, used three refrigerators of different construction, we have pleasure in stating that the last adopted, and invented by Mr. G. A. Wigney, and which we have now and have for some time had in use, is decidedly superior to the two preceding, affords us in every respect entire satisfaction, and is, in our opinion, the best that has yet been offered to the public.

(Signed) R. TAMPLIN & SON.

(Copy.)

Mr. G. A. Wigney.

Sir,—The cooling machine manufactured for me by Messrs. Williams and Yearsley, and which I understand is of your invention, is for its efficiency in cooling, the small quantity of liquor required, and the facility with which it can be cleaned, the best I ever saw to my knowledge. (Signed) HENRY MICHELL.

Carfax, Horsham, Dec. 12, 1835.

Refrigerator.

(Copy.)

Mr. G. A. Wigney.

Sir,—Convinced of the great superiority of the refrigerator of your invention, made for my son, of Horsham, by personal inspection and his representation of its effective performances, to any that I had ever seen or heard of, I was induced to have one like it, in lieu of one that I had for a long period in use, which did not do its work satisfactorily; and having had time and opportunity of fairly judging of its merits, by its practical effects upon my own premises, I am prompted to add my concurrent testimony to its value, by stating, that (without noticing accurately the details) about two barrels of water are quite sufficient to cool one barrel of wort by your refrigerator; that the water used for such purpose is quite fit for brewing, and being raised in temperature by an abstraction of heat from the wort, a saving of fuel results proportionate to the heat of the wort at the time its cooling is commenced, which may be done with perfect safety and advantage, in about a quarter of an hour after it is out of the copper, running the wort either from the hop or cooling back; that no injury to the wort in passing through the internal pipes occurs, and that they seldom require cleansing, (being always rinsed out and filled with water immediately the cooling is finished) and when they do need it, it can be performed with the greatest facility and ease; and in short, as a whole, it appears to me to possess all the capabilities that are requisite or desirable for the purpose, and am, Sir, yours, &c.

Brewery, Steyning, (Signed) EDWARD MICHELL.
Oct. 22, 1836.

Mr. G. A. Wigney. (Copy.)

Sir,—After a constant and extensive use of a Refrigerator of your invention, manufactured for us by Messrs. Williams and Yearsley, of Brighton, for upwards of three years, we can both with confidence and satisfaction, furnish you with our testimony in favor of its merits, and state that it cools a large quantity of wort in a short period, with a very moderate proportion of water; that it is capable of cooling wort to a temperature of 60 degrees or below, in the hottest weather; that it seldom requires any other cleansing than with cold or hot water, and that when it does, it is effected with facility; that we have never experienced the slightest injury to any of our worts from its use; and that whether taking its capabilities into consideration together or separate, we conceive that to the brewer it furnishes all that he can reasonably desire in a refrigerator; and we can assuredly state, that we know of no other equal to it.

Steyning, Jan. 12, 1837. (Signed) KEEPING & JONES.

(Copy.)

To Mr. G. A. Wigney, Carlisle, May 13, 1837.
21, Ship Street, Brighton.

Sir,—After several months' use of a refrigerator of your invention, made for us by Messrs. Williams and Yearsley, of Brighton, we are enabled fairly to judge of its merits; and in justice to you, are induced to state, that we have found it very effective in cooling, reducing the temperature of wort to 60 degrees and above, with a very moderate quantity of water; and that being constantly kept full of cold water, when not in use, the wort pipes require but seldom cleansing, other than occasionally rinsing with hot water; and when more effectual measures are requisite, the operation is performed with ease. And we beg to state generally, that we are well satisfied with the apparatus, and are of opinion, that it is calculated in every sense of the word, to satisfy the reasonable wishes of every brewer.

We are, Sir, your obedient servants,
(Signed) SIR RICHARD HODGSON & CO.

(Copy.)

Mr. G. A. Wigney,

Sir,—We have had in use, since August, 1837, a refrigerator of six cases, which you say is your invention. We have found it of great utility, having been able with it to cool worts from the cooler, to the required heat for letting into the working squares, at the ratio of 14 barrels per hour. (Signed) SELLER & SONS,
May 3, 1838. Brewers, Chester.

(Copy.)

To Mr. G. A. Wigney, Carlisle, West Walls Brewery,
Brewer, 21, Ship Street, Brighton. May 24, 1838.

Sir,—The very convincing and satisfactory proof which you furnished in your circular, and Practical Treatise on Malting and Brewing, of the superiority of the principles of construction of your refrigerator, to any other with which I was acquainted, and the numerous opportunities which I subsequently had of judging of its practical capabilities, induced me to have one manufactured by Messrs. Williams and Yearsley, and I have the pleasure to inform you, that I have in every sense of the word, most satisfactorily experienced the benefit of its use for a considerable period, and can with the utmost confidence recommend it to any brewer for its efficiency in cooling wort from the highest temperature to 60 degrees of heat, or below if requisite, with a speed proportionate to the amount of the reduction, and with a very moderate quantity of water; and without enumerating its several merits, it may be sufficient for me to say, that I have found your representation of it, fully borne out in every point to which you have called the attention of the public. And am, Sir, your obedient servant,
(Signed) RICHARD BROWN.

(Copy.)

To Mr. G. A. Wigney, Huyton, Lancashire,
Brewer, 21, Ship Street, Brighton. May 25, 1838.

Sir,—Having had the refrigerator of your invention made for us by Messrs. Williams and Yearsley, in constant use for more than twelve months, we are now able to speak confidently as to its merits, and we have the pleasure of being able to express our entire satisfaction as to its efficiency under every circumstance, and at every period of the year, and have found all your representations as to its capabilities fully exemplified in practice, and without hesitation we recommend it as calculated to impart as much satisfaction to every brewer as we have experienced in its use. We are, Sir, yours very respectfully,
Pro RICHARD BARKER & CO.
(Signed) WILLIAM BARKER.

(Copy.)

Respected Friend, Leeds, 6th month, 1838.
G. A. Wigney.

Before the receipt of thy last letter, I had not noticed anything of the powers of the refrigerator of thy invention; the following accounts are now at thy service:

1838. FIRST WORT.

5th Month, 1st.—Water in reservoir at 46 degrees ran from refrigerator at 71 degrees.

Heat of wort in back, 145 degrees, pitched in the tun at 58 degrees.

In one hour and eight minutes ran through about 13 barrels.

SECOND WORT.

Water in reservoir at 46 degrees ran from refrigerator at 85 degrees to 90 degrees.

Heat of wort in back, 153 degrees, pitched in the tun at 60 degrees.

In one hour and twenty minutes ran through about 21 barrels.

5th Month, 4th.—Water in reservoir at 48 degrees, ran from refrigerator at 87 degrees.

Heat of wort in back, 150 degrees, pitched in the tun at 60 degrees.

In one hour ran through about 13 barrels.

FIRST WORT.

5th Month, 8th.—Water in reservoir at 52 degrees, ran from refrigerator at 80 degrees.

Heat of wort in back, 150 degrees, pitched in the tun at 60 degrees.

In one hour and ten minutes, ran through 14 barrels.

SECOND WORT.

The heat of water not noticed.

Heat of wort in back, 100 degrees, pitched in the tun at 60 degrees.

In one hour ran through 13 barrels.

5th Month, 15th.—Water in reservoir at 50 degrees, ran from refrigerator at 80 degrees.

Heat of wort in back, 165 degrees, pitched in the tun at 60 degrees.

In two hours and forty minutes, ran through about 32 barrels.

The above are the accounts furnished to me by my brewer. I am well satisfied with the refrigerator, and consider its principle much superior to any other that I have seen.

I am, respectfully, thy Friend,
(Signed) ROBERT ARTHINGTON.

(Copy.)

Brighton, June 30 1838.

To Mr. G. A. Wigney,
Brewer, 21, Ship St. Brighton.

Sir,—Having frequently seen a refrigerator of your invention in operation, and observed its practical effects, we availed ourselves of the first suitable opportunity to direct Messrs. Williams and Yearsley to manufacture one for us in the room of another constructed upon a different principle, which we did not find sufficiently effective for our use: and we feel pleasure in adding our testimony to that of others in favor of its several merits as an effective, economical, convenient, and in every respect a most desirable apparatus for the intended purpose; and having experienced the most satisfactory results since we have had it in work, we do not hesitate strongly to recommend it to those, who may need the aid of so valuable an assistant in the process of brewing.

We are, Sir, your obedient Servants,
(Signed) SMITHERS & ISAACSON.

REMEDIABLE, *that may be remedied or cured.*

The maxims, that "no remedy should ever unnecessarily be needed," and that "when a remedy is necessarily needed, one should always be at hand," should be deeply inculcated on the mind of every manufacturer; and to frame a system for conducting business on correct and advantageous principles, founded on such maxims, every manufacturer should endeavour to obtain a correct and extensive elementary as well as practical knowledge on every subject connected with the materials and products of his manufacture, and the natural influences upon all his chemical or mechanical operations by surrounding bodies, in order that he may be able to avail himself of such as may prove beneficial, and avoid such as may prove injurious.

But as such requisite knowledge will produce the conviction, that the power to avail and avoid is not always within the control of the most experienced and best informed, the unceasing enquiry of such as possess it, should be for the best and most suitable remedies for all the unavoidable evils which they may have to encounter.

Although there may be some happy exceptions to the rule, yet the baneful rule in education is, to allow pupils to learn what they can or will, and not to teach them; and although they may have unlimited access to all the practical details, yet to all the elementary information, the barrier of ignorance or indisposition to communicate is immoveably opposed; and what the pupil sees he may imitate, but why or wherefore he should or should not deviate from the beaten track before him, he neither learns, or has another course to choose.

Confining our observations to the brewery, we find that as a general rule, the pupil enters without any previous, and continues without any subsequent chemical and physiological instructions; and few are probably aware, that brewing is a chemical operation, and the process powerfully affected by natural causes. All he learns is the mere practical details, and if they are founded on a tolerably good system, although he learns nothing of the principles that have induced them, yet his products may be decent, and the results advantageous; but should they be erroneous, he finds himself in a labyrinth, without any clue to direct his steps. He finds himself surrounded with difficulties and evils, and he knows not their source or origin; and all that he seeks is transient remedies. Quackery becomes his physician, distrust and suspicion his guides, despondency or despair his counsellor, and ruin his ignis fatuis.

REPRODUCTION, *the act of producing anew.*

Reproduction forms a prominent and advantageous portion of that system of providential economy, by which an abundant provision is made for the sustenance of all living creatures.

If the produce of a single species, was the result of every case of reproduction only, then indeed would the earth have been a solitary waste in the first age of its creation; but that beneficent being who devised, planned and executed the great work of creation, ordained manifold reproduction, and to an extent more than sufficient for the most profuse consumption, with an ample residue for reproduction.

The assiduous and intelligent observer will perceive, that every reproductive substance contains within itself the nucleus principles which are necessary to the reproduction of many similar substances, and that the accretion of atoms from various sources, are necessary to perfect the several similitudes, and that laws have been established by the divine being, which ensure and regulate the accretion.

An investigation of the internal structure of one seed of corn, and an observance of the development of the germinative functions of the several embryo similitudes, an attentive inspection of their gradual increase in dimensions by the accretion of atoms, a patient enquiry into the laws that induce and regulate their symmetrical union, and to trace the sources from which they are derived, constitute a pleasing, a rational, an instructive, and an ennobling employment.

REPULSION, *the act of driving off from itself.*

The term repulsion, implies an innate power possessed by one body or substance, to repel another body or substance to some sensible distance from itself; and there appears to be an impression on the mind of many, that some bodies possess a stationary or immoveable power of repelling others, instead of an active impartive principle passing from the repelling to the repellant body.

Judging by the evidence of sight alone, the principle of innate repulsion may appear to be indubitably proved by several electrical experiments, a variety of substances being repelled by electric bodies; but in these cases, the eye merely perceives the repelling and the repellant bodies, and not the electric fluid in its transition from one body to another, the force of which is the real cause of the divergence of the lighter body from the heavier; and whether the electric fluid may pass from the heavier body to the lighter, or from the lighter to the heavier, the repulsion of the lighter must be the necessary consequence, provided the force of motion of the electric fluid is superior to the force of gravity to which the lighter body is subject.

Judging the views of some writers by the indistinct and confused expression of their opinions relative to the repulsive power of heat, and deducing their ideas from the tenor of their reasoning, they seem to think that an atom of heat possesses the innate power in a quiescent state, to repel the surrounding ponderable atoms from it, and thereby cause the expansion of the body of which those atoms form a part; and to account for the expansion of a body, placed in the vicinity or in contact with a body in a state of combustion they appear to infer, that the repulsive power of the atoms of heat contained in the expanding body, is excited by the body in a state of combustion, and that being thus excited they each repel the surrounding ponderable atoms of which the body is composed, and thereby cause an extension in bulk of such body, proportionate to the amount of the repellant force excited into action. These notions if they really exist, and are not misunderstood, appear to us altogether unphilosophical, and unsupported by any concurrent testimony or analogical proofs; and that they are quite at variance with the laws of nature, and the experience of those who have most successfully investigated her works. That atoms of heat possess the power of separating the ponderable atoms of which a body is composed, and by such separation enlarge its bulk, we do not question or doubt; but we are of opinion, that such separation or expansion does not result from any innate power of repulsion possessed by the latent heat contained in such body, which is incited into action by some external or internal cause; but that when its expansion does occur, the effect is due to the transition of heat thereto from some contiguous body possessing more heat than itself, and that the power of such transferred heat, may more properly be denominated insinuative than repulsive; and we are decidedly of opinion, that the effect of expansion by heat is the result of its obedience to the law of equal diffusion, whereby it passes from the body possessing most active heat, to the body possessing the least; and not merely to the exterior of such body, but to the interior also; and if the transferred heat from the one body to the other, is more than sufficient to fill up the interstices between the ponderable atoms united by attraction of cohesion of which such body is composed, or if those interstices are previously filled, then will the transferred atoms of heat, in virtue of the power of equal diffusion which they possess, separate the ponderable atoms of which the body is composed; and again, if the ponderable atoms of such body are not united by attraction of cohesion, but are merely held together by the attraction of aggregation, as in fluids or gases, then will the transferred atoms of heat, separate still farther from each other, the ponderable atoms of which such fluid or gaseous body is composed.

The doctrine of the innate power of bodies to repel each other, is strongly opposed to the law of gravity; and the innate power of heat to repel the ponderable atoms which surround it, implies the occurrence of a natural vacuum, which is altogether at variance with the results of the researches of the most eminent scientific men.

RESERVOIR, *a conservatory of water.*

To a manufacturer who needs water as a motive power, a menstruum, or a detergent, a competent reservoir and its conservation without waste or injury, are points of primary consideration.

It is the practice of some who have the choice of a situation for a reservoir, either within or without the roof of a factory, to prefer the latter situation, and often at some extra cost and inconvenience, under the impression that water exposed to the air is thereby rendered more suitable for use as a menstruum. Water thus exposed becomes the receptacle of many vegetable seeds, which are conveyed to it by the atmosphere, and which germinate and vegetate therein; and we should apprehend, that the acid which renders water what is technically called hard is abstracted by the vegetable seeds, during the germinative and vegetative processes, and is thereby rendered what is technically called soft, and consequently better adapted as a menstruum.

However correct may be such an opinion, there is much reason to suppose, that the practice of placing reservoirs in such situations, is too implicitly and blindly followed, without any enquiry as to the quality of the water, with which the premises are to be supplied, and whether hard or soft. The scite is chosen regardless of the injury which such germinative and vegetative processes, and the admixture of soot, ovala of animalcules, and a variety of impurities may cause to the water. Prejudices, habits and erroneous practices, are often established and propagated through ignorance, and followed through indolence; and if an enquiry could be made of the architect of every new brewery, which has been built during the last century, with the reservoir placed outside of the roof, what was the motive that induced the choice of such a situation? the probable reply would be; oh! I do not know, other than it is generally the custom so to do.

Custom is too much the guide to men's actions, and presents a powerful barrier to improvement. If an architect is required to furnish a plan for a brewery, he becomes a copyist, and not an originator, and all that he conceives is necessary for him to do, is to select the plan of the best adapted brewery which he can find agreeable to the dictates of his own judgment; and his mind being uninformed upon the subject of brewing, he cannot be competent to devise either the building or the mode of fitting it up, so as to enable the various processes to be performed therein, upon the best chemical and mechanical principles.

ROOT, *the fibrous part of a plant, &c. which rests and extends in various directions in the ground.*

Every created substance evinces the consummate wisdom of the creator, exemplifies the admirable design with which every contrivance is rendered suitable to the accomplishment of the work, and the wonderful skill with which the performance is effected.

The small and apparently insignificant seed which is imbedded in the earth, contains the rudiments of the wide spreading roots, the lofty and enormous trunk, the far extending branches, the host of leaves, and rich array of fruit, of the tall tree that towers to the skies, resting securely on its radiating base, erect and steadfast in the wildest storm.

Root.

The first external evidence of the germination of seed, is the protrusion of the root from one end, while the plumula or future stem, is slowly and gradually advancing within toward the other end.

By the time the plumula is ready to protrude, the root has made considerable external progress, and is divided into several branches extending in different directions; and the design of the protrusion of the root previous to that of the plumula, is evident from the purport of its future use—its extension within the earth being necessary to form a base for the future plant; and as it is necessary that the base should always precede the structure, so has "the wise master builder" ordained that the base of the plant should be prepared previous to the protrusion of the stem. And again, as by the root the future sustenance of the stem is to be conveyed, so is it necessary that the root should be sufficiently developed, extended and matured, as to be ready for the purpose of conveying the sustenance as soon as it is required.

Previous to germination, the seed contains the embryo radicle and the plumula, and an internal supply of nutriment to a limited extent for both.

The vital principle being called into action, an accretion to the radicle and plumula immediately commences, of that internal nutriment which is designed and adapted to promote their extension and exit from the body of the seed, and which is continued until the stock is spent. By such time a union between the radicle and plumula has been effected, and the former is converted into hollow radiating tubes, for the purpose of conveying fluids by capillary attraction to the plumula or future stem; nor should it escape the observation that these tubes are of various lengths, and extend in every direction, seemingly in instinctive pursuit of those nutritious fluids with which the earth is continually impregnated—short tubes for the reception of such as is in the immediate or near vicinity of the stem, and long with intermediate lengths, to receive such as is more or less remotely situated.

The root, which may be termed the sucker, the receiver, the conveyer of fluid nutriment to the thriving stem, appears to be not unmindful of its present need, and future work; and seems instinctively to appropriate a portion of such nutriment by continual accretion to an extension of its length, its bulk, an enlargement of its tubes, and an increase in the number of its fibres; as if conscious of the accumulating demands for more nourishment by the insatiate trunk, and for a more stable base, as it rears its lofty and well leafed head. But we do not intend to infer from such analogical illustration, that we imagine the roots of plants are gifted with instinctive or reasoning faculties, similar to such as all the animate tribes are endowed with, but faculties and powers equivalent to the instinctive with which they are endowed, and by the exercise and operation of which they fulfil all the purposes to which they are designed and for which created.

The accretion of atoms from the fluid which circulates from the extremities of the root to the remotest leaf, is from within the channel in which the sap circulates, causing the gradual distension of every part, until the final limits of accretion are attained to.

ROPY, *viscous*, *glutinous*, *clammy*, *slimy*.

Beer in a ropy state, exhibits the appearance of oil, when running from the tap, the stream being viscid, and occasioning no froth or bubbles, as results from beer in proper condition.

The cause of this viscidity appears to be a combination of the oxygen of the atmosphere, with the gum or gluten of the wort, and is generally the result of negligence, or an erroneous system of brewing, or an improper method of subsequent management.

This improper combination of the oxygen with the gum or gluten, often occurs in the under back or in the cooling backs, or from taking improper mashing heats; and the combination sometimes occurs after fermentation.

The occurrence in the under back and cooling backs, is generally the result of too long an exposure of the wort to an oxygenated atmosphere; and when the result of improper mashing heats, the effect may be attributed to an improper solution and blending of the gum or gluten with the fecula or saccharum, causing an improper combination of the oxygen of the atmosphere, and the consequent injurious results. Ropiness is therefore a costly proof of the effect of carelessness, or of the want of that knowledge, which is necessary to induce the adoption of proper measures to prevent its occurrence.

Ropiness may be removed from beer with facility, and at a small cost, and although the remedy is much better than the disease, yet in this case, as in all others, "prevention is better than cure," as after removal the beer is not equal in quality to what it might have been, had it never been in such a condition.

RUDIMENTS, *the first principles of a science*,

In germination we first perceive the protrusion of the root, then the stem; and tracing the progress of vegetation, we observe the slow yet progressive growth of the trunk, the branches, the leaves, and finally the fruit. In scholastic education, the commencement is the alphabet, the primer, the spelling book, and passing slowly upwards through gradatory works and performances, the finish is the sciences or the classics. But the manufacturing education too often commences at the top, and traces its weary and humiliating progress downward; the pupil being transferred from the school, in which he perhaps, or rather most probably has not received a preparatory scientific education, previous to his entering upon the practical operations of the factory; and should he be the son of an indiscriminating proprietor, he may at once be placed as an operative or superintendant in the highest practical department, instead of being placed in an initiatory employment, and well grounded in a theoretical knowledge of the rudimental principles of such sciences, as are intimately connected with the several processes of manufacture in which he is about to be engaged; and progressing gradually onward with a speed proportionate to his attainments until he finally reaches the highest station, as the meed of his several acquirements. The youth who thus injudiciously, and therefore unfortunately may be thrust into avocations, and the performance of duties, which should be conducted and fulfilled by men possessing knowledge, skill, experience, perseverance and industry, and all whose passions comparatively speaking, have been absorbed and intimately blended with the pursuits and routine of business; will find when sobered into manhood by difficulties, perplexities, cares and vicissitudes, that his undiscerning parent placed him on the pinnacle instead of at the base; and when involved in years, in losses, crosses, and anxieties of business, he will begin to perceive the necessity and to feel a desire for the obtainment of a rudimental knowledge of his business, without the means of gratifying his desires, and perceive too late, that he should have left off where he begun.

As all knowledge is expressed and communicated in some vernacular language, and such language is compounded of sentences, words and letters; so therefore is it necessary in order to convey any requisite intelligence in writing, printing, &c. that the informant should possess an elementary knowledge of the language in which he is desirous of expressing himself; and consequently it is indispensably necessary that he should be well acquainted with the form and meaning of every letter in the alphabet, in order that he may be able to construct both words and sentences, for the expression of opinions, sentiments, facts, &c. and without such knowledge he is incompetent to record by such means, the information which he wishes to convey. But he may be able to communicate it orally, and be competent to converse freely, intelligently, and even eloquently without the knowledge of a single letter of the alphabet; and of such a person we might probably say, that he was a very clever speaker, but that such was his ignorance, that he was even unacquainted with the rudiments of the language in which he spoke; and much as we might admire his fluency, his acuteness, intelligence and eloquence, we should feel all the force of the abstractive consideration, that the result of his talents were but as evanescent as the breath with which he recorded them, and the thin subtle rapid flowing air which conveyed his expressions to the pleased ears of his admiring auditory. And how did he acquire this knowledge of language, the freedom of its utterance, the store of truths or fictions, hypotheses and sentiments, and the power of eloquence to unfold, elucidate and reveal them to his fellow men? By the same transient methods, by which he is able to transmit them! By oral communication, traditionary transmission, attentive observation, acute discernment committed to a retentive memory, and well organized mental faculties, a surface cultured understanding, a capacious and unceasingly replenished intellectual fountain, from which source may glide the broad and glittering stream of eloquence, conveying to the minds of others many a rich and pleasing freight of useful and instructive, as well as meretricious knowledge. But such a mind is not furnished by a rudimental spring: the source of his acquirements is not the caverned reservoir that never fails, supplied by streamlets percolating through many a black stained page of strata volumes, which ever gently flow and irrigate a countless host of youthful minds! But it is the mountain torrent; a wide capacious shallow flood; an ephemereal production; an effort extraordinary of nature, which rushes down the plain, and spreads fertility or desolating ruin all around.

And is there no analagous resemblance between the unlettered linguist, and the mere practical manufacturer? Most certainly there is; for as the former is not rudimentally acquainted with the words composing sentences, and the letters composing words; so the latter has not an intimate knowledge of the substances which compose the materials of his manufacture, or of the atoms which compose those substances; and therefore however well versed a manufacturer may be in the practical system which he may have learnt, yet he is incapable for want of such elementary knowledge, of successfully deviating from his accustomed processes, when fortuitous cirumstances, variation of material, or the qualities or properties of the customary material, change of seasons, alteration of public opinion or taste, and many other incidental causes may require; and he is but as a coasting pilot, far at sea and from his landmarks, yet with compass and chart of which he has no rudimental knowledge.

RUST, *the red incrustation of iron, the tarnished corroded surface of any metal.*

Common observation must convince, that the external surface of iron, which is of a color approximating to black, is by exposure to the atmosphere soon changed to a reddish brown color; and that it is by an accretion of some principle to the iron derived from the atmosphere, that such a change is effected; and chemists have determined that such principle is oxygen, and in chemical language the surface is said to be oxidated.

If the surface of iron is covered with paint or a variety of other substances, as soon as it is removed from the forge, such an oxidation will not occur, as the covering substance protects it from the access of air.

The combination of the oxygen with the iron is chemical, and not simple or mechanical; it is not a mere addition to its surface which may be blown or wiped off, leaving the iron uninjured and undiminished, but its removal cannot be effected but with force, and a diminution of the iron's bulk.

Such a combination of oxygen with iron, is the result of affinity and attraction between it and the atoms of which iron is partly composed; and the attentive observer may watch the progress of such combination from the appearance of the first speck, to the final decomposition of the iron's bulk, leaving but a dusty heap, called oxide of iron.

The brewer may learn a lesson from the wasting of his iron hoops by rust, that the same atmosphere which imparts oxygen thereto, and effects their decomposition, is equally capable of imparting the same principle to his wort; and he may trace a strict analogy between the iron that leaves the forge, and the wort that leaves the mash tun, both being free from oxidation, yet both liable to it by an exposure to the atmosphere. He may also observe that dry iron is less liable to oxidate than wet, and that the extract of malt in solution, is much more liable to oxidation than if in a dry state. He may also perceive that the iron experiences a change of color by oxidation, first on the surface which soon scales off, withdrawing a portion of the iron which has united with the oxygen, leaving another surface subject to oxidation; and that this process continues until the whole of the iron is consumed, in forming the compound called oxide of iron.

And thus with malt on the kiln, the whole of its moisture being expelled by heat, and the impartation of oxygen continuing by the aid of heat, its external surface is gradually changed in color, and the interior experiences a change in color also, gradually passing from a state of whiteness through the gradatory hues to blackness, provided the impartation of oxygen is sufficiently long continued.

Nor is wort less proportionately affected in color by the impartation of oxygen from the atmosphere, assuming by its combination a darker hue, proportionate to the amount of oxygen imparted; and this increase in the intensity in color, is more apparent in the formation of vinegar than beer, as the quantity imparted is to a much greater amount.

The weight of iron is increased by oxidation; and in the oxidation of common lead, with a view to convert it into red lead, it is stated that 20 cwt. of the former will produce 22 cwt. of the latter, the increase being attributable to the impartation of oxygen, as well as the change in color.

But the impartation of oxygen to the wort, will decrease its weight, provided the result of the combination is the production and evolation of carbonic acid gas; but without an evolation of such or other gas, the impartation of oxygen to wort causes an increase of its statical weight, and its density as exhibited by the saccharometer; and it will be found on examination, that when a wort has been attenuated by a vinous fermentation as low as it is possible, and an acetous fermentation follows, that then the statical weight and density of such wort will gradually increase, and to a proportionate extent to the impartation of oxygen.

SACCHARINE, *a substance having the taste and properties of sugar.*

Many esculent vegetables, fruits, and species of grain, contain saccharine matter in a natural state, and are capable of producing a much larger quantity by the process of germination and fermentation.

The natural quantity of saccharine matter found in grain, appears to be a stock or fund, formed within the interior, in the last stage of accretion to the seed, and is due to the impartation of oxygen, aided by the calorific rays of the sun; and the purport of the formation is a preliminary supply of nutritious matter for the radicle and plumula, ready for an accretion of a portion of its atoms thereto, as soon as the process of germination commences.

In addition to this fund of saccharine matter, created previous to the commencement of the process of germination, and for the purpose of aiding and contributing to its progress, the internal contents of grain consist of such materials, as are partly convertible into saccharum by the addition of oxygen from the atmosphere, and the abstraction of carbon from the seed; and by such formation a provision is admirably made of suitable nutriment for the growth both of the radicle and plumula.

The process of germination conducted by the maltster, (who studies the brewer's interest) is for the purpose of creating saccharum, as forming the most valuable product of malted grain in the operation of brewing; and his aim is, to create as much and lose as little of it as he possibly can. He is or ought to be fully aware, that all the saccharum that is imparted to the radicle or plumula, is a loss of a portion of that which was gained. But he cannot do without the radicle, inasmuch as it consists of several hollow tubes protruding from the grain, and by them the oxygen of the atmosphere is conveyed to the carbon of the grain, and without it he could not create saccharum; and therefore he must content himself with the needful consumption of saccharum, to enable the radicle to fulfil its functions, or his stock of saccharum would not increase; and all he can do is to prevent an unnecessary rapidity of its growth, and to limit its extent within the bounds of a proper fulfilment of its functions. And as to the plumula, for his purpose, its growth is apparently useless, inasmuch as it robs him of his saccharum. But nature's purposes are not to be thwarted by the avarice of man! she has ordained the formation of saccharum for an especial purpose—its gradual accretion to the radicle and plumula; and that the formation and accretion should be simultaneously performed, and therefore man is not allowed by art to form saccharum, without devoting a portion to nature's purpose. Yet although she has restrained him from accomplishing his avaricious wishes to the full extent, yet she has bountifully allowed him to create saccharum in advance of the maximum consumption, to carry on the process of creation to the extent of his own will, to stay it when he pleases, and to prevent its waste as much as in him lies; and agreeable to such permissive decree, the endeavour of the intelligent maltster is to create all he can, to lose as little as is possible during the formation, and to stop the process when he perceives that consumption begins to exceed creation; and hence his desire to keep a short root, and the plumula or acrospire from protrusion.

SACCHAROMETER, *an instrument to ascertain the density and specific gravity of fluids.*

The purport of the saccharometer in the manufactories of those who are interested in the value of soluble extracts, from whatever material they may be obtained, is to enable them to discover that value, as relates to quantity but not to quality.

The saccharometer is an ingenious and most valuable substitute for scales and weights, enabling the manufacturer to ascertain by a small sample, the amount of soluble extract contained in a given bulk of any fluid, without resorting to the inconvenience of weighing statically, any portion of that bulk, and then making abstruse calculations founded on the variable temperature of the bulk.

We conceive that the instrument is improperly named, and that from the name and the purport of its use, it may induce the erroneus opinion, that all the extract obtained from grain or any other substance is saccharum; and as such extracts are always compounded of two or more substances, we are of opinion that a more suitable appellation might have been conferred upon it.

Several saccharometers varying in mechanical construction yet agreeing in principle, have been furnished to the public, indicating the specific gravity of extracts; the quantity of proof spirit which it is estimated that one hundred gallons of fermented extract will yield by distillation, according to the amount of the reduction in the specific gravity, resulting from fermentation (technically termed the amount of attenuation); the quantity of dry extract contained in a barrel, or in one hundred gallons of the wort or wash, as would be evinced by an evaporation of the whole of the menstruum, leaving the extract in a dry state; and also the density of wort or wash per barrel.

In mechanical construction, the saccharometer generally consists of an egg-shaped hollow copper vessel, to one end of which is affixed a flat or square solid stem of brass, which is graduated by long and short cross lines, indicative of pounds, and tenths of a pound, and figured, extending from 0 to any number (say 52lbs) that may be convenient; and to the other end is affixed, a small cylindrical brass rod, terminating in a small solid egg-shaped knob of brass, this stem and knob being a counterbalance to the graduated stem, and for the purpose of enabling the instrument to float perpendicularly. A set of small brass weights also accompany the instrument, which are as occasion may require, affixed to the upper or lower stem.

It is desirable that both the saccharometer and the weights should be gilt, in order to prevent oxidation, by which precaution the instrument is not only much more durable, but is less likely to become inaccurate in its indications.

The weight of the saccharometer is made just equal to the weight of as much distilled water at a given temperature, (say 50 degrees) as the saccharometer will displace, when immersed in it so far as to float at such a depth therein, as to sink to the line beneath 0, on the upper stem, and the weight of the water thus displaced is called 1000.

It scarcely need be observed, that if this instrument was constructed entirely of solid metal, that it would not float in water; but as the egg-shaped vessel between the two stems is hollow and filled with air, the weight of that portion of the metal of which the instrument is formed, and the enclosed air, up to the line beneath 0, is not quite equal to the weight of the water displaced, the difference in the weight being, as much as that portion of the upper stem above the line beneath 0 would weigh, if cut off and placed in the scale.

To assist the mind in comprehending this explanation, it may be necessary to state, that if a vessel is carefully and accurately filled with distilled water, and the saccharometer is inserted, and sinks in the water to the line beneath 0, on the upper stem; and that such saccharometer is next withdrawn, and both the saccharometer and the displaced water are weighed, that they will be found to be of equal weight; but as more water would have been displaced had the whole of the stem been immersed, so such extra quantity of water thereby displaced, if weighed separately, would exhibit the difference in the weight of the saccharometer, and the total bulk of water displaced by its entire immersion.

Having explained the principle of construction of the saccharometer, and the mechanical details, we will next proceed to explain the principle on which the graduation of the scale on the upper stem is effected, calculating by the data furnished by Dicas, and assuming that it is correct. But it is necessary here to state, that there appears to be a discrepancy in the data upon which some of the saccharometers are graduated, and consequently that there is a difference in their indications, causing an inconvenient and injurious apprehension frequently in comparing the produce of malt obtained by different brewers, who use different saccharometers. Thus if one brewer is desirous of knowing if his malt is equal in quality to another brewer's, or if his system of extraction is as good, and he is told that the other obtains 90lbs per quarter, and he finds that he obtains but 80 to 85lbs, he becomes perhaps discontented with his malt, or his system of extraction, not being aware that the other brewer is using a different saccharometer to himself, and that probably the apparent difference in the produce may be attributable to the difference in the indications of the saccharometers, and not to the quality of the malt or the system of extraction. Or a brewer may be deceived into complacency or exultation, by an apparent superiority in produce, which he may attribute to a superior system in malting or brewing, judging by the declarations of other brewers as to the amount of their obtainments, when he may be actually obtaining less, his deception resulting from the difference in the indication of his own and the saccharometers of others.

The data on which Dicas's saccharometer is constructed, is that if two pounds and a half of dry extract of malt are inserted into a barrel accurately filled with distilled water at 50 degrees of heat, that the extract will displace one pound and a half of water; and computing the weight of a barrel of water at 360 pounds, a barrel of wort formed by such insertion will weigh 361 pounds; and consequently we are to understand by his data, that the scale weight of a barrel of such wort without the displaced water is 361 pounds, and the density one pound; and that every barrel of water not absorbed by the grain, has extracted two and a half pounds of soluble matter therefrom.

The propriety of the word density is evidenced by the fact, that as two and a half pounds of dry extract only displace one and a half pounds of water, that the ponderable atoms of the extract and water are more densely compacted than were the ponderable atoms of the water; and this increase in density is therefore stated at one pound, as an accurate and easy mode of computing the value of a barrel of such wort above the value of a barrel of water by some manufacturers' saccharometers, while Dicas prefers his instrument should indicate the two and a half pounds of dry extract which has been obtained from the malt, or grain, &c. But to us it appears, that as there is an addition to the quantity, in the ratio of one pound and a half of water per every barrel by the addition of two and a half pounds of malt extract, so any definite number of barrels of wort will not express the amount of malt extract contained therein, in the ratio of two and a half pounds per barrel, and as the purport of the brewer is to ascertain the quantity of extract contained in a barrel of his wort, and not how much every barrel of water used as a menstruum may have obtained, so the indication of one pound density instead of two and a half pounds extract, will more accurately accomplish his purpose.

If the brewer had but one purpose in using a saccharometer, that which relates to the apportionment of an invariable quantity of malt extract to every barrel of wort, intended to be sold at a definite price, so as to ensure an equable quality of his products at the several prices, it would be immaterial to him what saccharometer he used, provided its accuracy was consistent with itself, or in other words provided it was always kept correctly adjusted to water, and the scale on the upper stem was correctly graduated, and the weights of relatively correct proportions; but as he is also desirous of supplying the public with as good beer as other brewers, and as the allotment of an equal quantity of extract of malt to every barrel of wort, to such as they allow at any definite price, is one of the essential conditions to the supply of beer of equal quality, so is it not only necessary that he should ascertain the quantity of extract which they allow by some definite standard, but that he should possess an instrument which is able as correctly to measure the several apportionments agreeable to the indications of such standard. And again, if he is desirous to ascertain the value of his malt, or system of extraction by that of other brewers, he requires a saccharometer of corresponding indications to theirs, or otherwise he cannot come to a correct conclusion. And it is much to be regretted that one standard of universal adoption is not established for the construction of all saccharometers, and that every maker, let the form or modification of his instrument be whatever it may, should cause its indications to accurately correspond with the indications of the instruments of others.

SCIENCE, *knowledge, deep learning, skill, art.*

In relation to the arts, manufactures, agricultural labours, and the multifarious transactions of business, knowledge may be divided and classed under the heads theoretical and practical.

Science.

By the term science, we understand it to imply that species of knowledge, in the obtainment of which the mind is exclusively engaged, without the aid of the bodily organs, let the subject of acquirement be what it may; and that the purport of its use is to distinguish it from that peculiar knowledge which results from the combined exercise of the mental and physical powers.

The possession of scientific knowledge by those manufacturers whose manipulations are chemical, is truly desirable; for although they may have to operate upon tangible materials, and such as the sight and taste may be sufficient to take cognizance of and inform the mind of their names, qualities, &c. yet the natural senses are not able to communicate to it an analytical division of those materials, into the several substances of which they are compounded, and unfold their various properties, and direct a synthetical composition of new bodies by a correct admixture, arrangement or re-arrangement of several bodies or substances; and not having obtained a requisite knowledge of the substances of which the materials of their manufacture are compounded, they are totally unacquainted with the atomic composition of the several substances, and the various laws to which they are subject, resulting from the contact or vicinity of other bodies substances, or atoms; and being destitute of such knowledge, their several processes may be termed, the heterogeneous manipulations of mere practice.

It too frequently occurs, that the practical man is destitute of all scientific or theoretical knowledge, or deficient in the possession of a sufficient quantity, and is therefore unable to turn his practical capabilities to the best account; and such a person may be said to possess skilful hands, but needs a wise head to direct their advantageous use; and it is much to be regretted, that such a person is too often under the influence of a sovereign contempt for all scientific knowledge and its possessors.

Science may illustratively be termed the offspring of theory and practice, the result of their combined efforts to produce knowledge and elucidate facts. Theory furnishes conjectures, and practice proofs, and the result is an abortion or a well formed truth; and if the latter, it is reared by wisdom, and placed among a class best suited to its adaptations.

A mere practical maltster in the usual acceptation of the term, may pass through all the routine of the process of malting, and produce good or bad malt as the case may be, without the possession of that scientific knowledge of the subject which is not only necessary to enable him to perceive the cause which produces the effect, but also to control and direct the cause, and ensure an advantageous effect. But the scientific maltster who is well acquainted with the substances composing his grain, and the atomic composition of those substances as well as the water in which he intends to steep it, and the air which will subsequently envelop it during the processes of germination, dessication, saccharification, coloring and flavoring, and the several laws to which such atoms are subject, will, previous to his steeping such grain, foresee many probable results which may occur during those several processes, from the quality, state and condition of such grain, water and air, and endeavour to avail himself of those preventive and remedial measures which may be well known to him as calculated to avoid or avert the contemplated injurious effects; and in case he is conscious of being destitute of the necessary scientific knowledge to effect his purpose, he will then call to his aid a supply of theoretical knowledge, and test it by practical proof, noting well the result; and should the anticipated effect be realized, he will set it down as a doubtful case, and defer a decision on its merits until another opportunity occurs again to test it; and should the same effect be produced, attended with indubitable evidence, that the result is the legitimate offspring of the cause, he will add it to his stock of scientific knowledge, and furnish another proof that science is the lawful child of theory and practice.

Whatever may be the material of manufacture, the manufacturer will ever stand in relation to science, more or less in the same situation as the maltster, as his required processes are separately or jointly chemical or mechanical.

But it may be urged by some, that many an important discovery in the various branches of science, have been the casual productions of random practice, and therefore, what can theory have had to do in the transaction? and can they be said to be the legitimate offspring of theory and practice? most certainly they were, for although the fortuitous and unnatural production of practice, and brought to the birth, yet they needed life and animation which theory alone could bestow, and without its reception they would have been buried in oblivion as soon as born. But the radiant light of knowledge from some illumined mind, shone upon each bantling ere it was buried, quickened it with theory, and caused the circulating flood of scientific life to flow through every vein, and presented it a living boon to human kind.

And it is the lot of many a mere practical manufacturer, to give birth to some important discovery, unconscious of the deed, leaving to the passing theorist, the task of giving life, and disclosing to the public the value of the foundling, who derive the profit from their labours.

SEDIMENT, *the material which settles at the bottom of liquids.*

The admixture of all substances with liquids may be considered under two different heads—mechanical and chemical combination.

The mechanical combination of any substance with a liquid is evinced by an immediate or subsequent separation of the substance added, from the liquid with which it is mixed, either by collective suspension, depuration, or filtration.

The chemical combination of a substance with a liquid, is that intimate admixture of the substance by solution with the liquid, as not to admit of its separation by any other than chemical means, such as precipitation, fermentation, decomposition, distillation, &c.

Many liquids apparently pure will furnish a sediment by mechanical depuration, or by chemical precipitation, fermentation, decomposition, &c.

The purity of a liquid is commonly tested by the eye or taste, but critically by some chemical test, or mechanical separation.

In the process of brewing, the soluble materials of which malted or unmalted grain is composed, are first blended with the menstruum in a state of chemical admixture and the product is called wort; and in the second stage, a partial decomposition of such wort is effected by ebullition, a coagulation of a portion of the component gluten being the result, and which being separated from the wort in the hop back and cooling backs, forms the sediment which may be observed therein. In the third stage, a further partial decomposition of such wort occurs in the first or foul process of fermentation, resulting in the coagulation of a yet further portion of gluten, as exhibited in the form of yeast, which is separated from the wort by ejection, depuration, and precipitation. In the fourth stage, an additional decomposition takes place in the second or insensible process of fermentation, and the product forms a sediment by depuration or precipitation.

The sediment of fermentable fluids, whether in the form of yeast or lees, contains a considerable quantity of spirit, of which an immense quantity might be annually separated, and rendered available by distillation in various establishments, did not the revenue laws prevent.

The sediment of vinous fluids is subject to the liability of an acetous fermentation, much more promptly than the fluid which may be drawn from it, as it possesses a greater proportion of the base of acetous acid than the vinous fluid, and consequently the oxygen of the atmosphere more readily and rapidly combines with it.

SIPHON, *a bent tube, an instrument to convey fluids.*

The siphon forms a most useful hydraulic instrument for the transmission of a fluid from one vessel or situation to another, in a variety of cases, as a more convenient and suitable apparatus than others.

The siphon consists of a tube bent in such a way, as that one arm shall be a little longer than the other, fitted up either with or without a cock, and an air pipe attached to an orifice in the side, and near the end of the longest arm.

The siphon is most commonly used to draw off a portion of the liquid contained in a cask or other vessel, which cannot conveniently be tapped for the purpose of drawing off the whole. The shortest leg being inserted into the bunghole of the cask, the mouth is applied to the air pipe attached to the longest arm hanging outside of the cask, in such a position as that its end shall be lower than the end of the shorter arm within side, and at the same time the orifice of the outer arm is closed by the finger or the palm of the hand, when the whole, or nearly the whole of the air contained in the siphon, must be drawn therefrom by an inspiration of the lungs, which creating a vacuum therein, the liquid in the cask is forced up the short arm of the siphon, and over the bend by the pressure of the atmosphere on the liquid within the cask, and which on the removal of the finger or hand, will run and continue to run from the longer arm into the recipient vessel, until the diminution of the fluid in the cask is such, as that the pressure of the atmosphere on the orifice of the external arm, and the weight of the liquid therein, becomes equal to the pressure of the atmosphere on the orifice of the internal arm and the weight of the liquid therein.

As it is necessary that the whole or nearly the whole of the air should be withdrawn from the siphon, the diameter and length of the pipe of which it is formed should be such, as to contain no more air than can be withdrawn by one inspiration of the lungs, to render it an instrument of easy and convenient utility; but in cases of importance and necessity, when it is requisite that the dimensions should be large, the air may be withdrawn by a syringe or air pump, or the siphon may be filled with liquid, either previous or subsequent to its insertion in the fluid to be withdrawn.

In a variety of cases the siphon might be used to convey water to a very considerable distance, and to a great amount, from a higher to a lower level, over acclivities which it might not be convenient, economical, or possible to level or excavate, by abstracting the air therefrom by means of an air pump, or by filling the siphon with water, and thereby causing an expulsion of the air therefrom.

SOLID, *a material substance, whose component atoms are closely united by attraction of cohesion.*

All substances, whether solid, fluid, or gaseous, are supposed to be compounded of ponderable and imponderable atoms.

Both the ponderable and imponderable atoms, are supposed to be divided into species or classes, equivalent to sexual;

influenced to union by affinity or the love of atoms; subject to union by simple, aggregate and cohesive attraction; and possessing separate and conjoint properties.

The form of atoms is supposed to be spherical, and consequently that when closely united, there are spaces or interstices presented between.

A solid is considered to be compounded of ponderable atoms of different species, closely united and held together by attraction of cohesion; and that the interstices between are partially or totally filled with imponderable atoms.

The ponderable atoms may be termed resident and fixed, unless removed by a superior force to the attraction of cohesion by which they are held in union; but the imponderable may be termed fugitive, and subject to continual change and interchange.

The ponderable atoms of which a solid is composed, are subject to the law of gravity, or tendency to fall toward the centre of the earth, and from this law they derive the property of ponderosity.

The imponderable atoms which enter into the composition of a solid, are subject to the law of recession, or a tendency to recede from the centre of the earth; or (which is equivalent) to fall toward the centre of the sun, and from this law they derive the property of imponderosity.

The law of recession to which the imponderable atoms are subject is a secondary law, and the primary law is equal diffusion.

The principal and most familiar species of the ponderable atoms with which we are acquainted, are enumerated under the terms of oxygen, hydrogen,. carbon and nitrogen; and of the imponderable, under the terms of heat and light.

Some of the species enter into the composition of all known bodies; and bodies whether solid, fluid, or gaseous, possess a variable portion of the imponderable atoms of heat, as a prescribed and necessary constituent of each.

Bodies, solid, fluid, and gaseous, are the natural magazines of the imponderable atoms of heat, and some also of the atoms of light; in which they are tributary alone to the law of equal diffusion, and in obedience to that law are ever ready for instant transition to other bodies.

Solids differ from fluids inasmuch as the ponderable atoms of which they are composed are immoveable, being closely and firmly united by attraction of cohesion; whereas the ponderable atoms of fluids are subject to motion, not being closely united by attraction of cohesion.

The atoms of heat which are the constituents of a solid in its natural state, are not greater in amount than is sufficient to fill the interstices presented by the union of the ponderable atoms, and consequently the attraction of cohesion by which they are held together is unopposed and undiminished; but if a greater quantity of heat is imparted to a solid than such interstices can contain, then is the attraction of cohesion overpowered by the superior power of equal diffusion to which heat is subject, and the ponderable atoms of which the solid is composed are separated one from the other; and being thereby susceptible of free and unrestricted motion among themselves, the solid becomes either a fluid or gaseous body, as the amount of heat imparted may constitute it.

All bodies, whether solid, fluid or gaseous, are transmutable into either state, by the addition or abstraction of a sufficient quantity of heat.

Solids are susceptible of an increase in bulk by an accretion of atoms, or a decrease by abstraction.

The accretion of atoms to a solid, is induced by the affinity which subsists between one or more species of atoms of which the body is composed, and of atoms composing the liquid or gaseous fluid, in which such solid is enveloped, and which are within the sphere of attraction of aggregation of the atoms composing the solid, provided the atoms composing the liquid or gaseous fluid are not withheld from union with the solid, by the exercise of a more powerful attraction of aggregation subsisting between the atoms of which the liquid or gaseous fluid are composed.

The abstraction of atoms from a solid must be preceded by the accretion of atoms thereto; by the removal of the atoms to be abstracted from their former situation in the solid; by the consequent liberation of heat contained in the interstices between the atoms of the solid previous to their disunion; by the union of such heat with the disunited atoms of the solid and the accreting atoms thereto; by the consequent formation of a new compound, specifically lighter than the liquid or gaseous fluid in which the solid is enveloped, and its consequent evolation therefrom.

To illustrate this principle, which involves the decomposition of solid bodies in one of the several ways to which they are subject, let us imagine a solid body composed of certain proportions of the several species of atoms of oxygen, carbon, nitrogen and heat, and that the proportion of carbon is predominant: that each solid is enveloped in the gaseous fluid termed the atmosphere: that such atmosphere is compounded of pure air and sundry gases, and that oxygen forms a predominant constituent of those gases: that mutual affinity subsists between the carbon of the solid and the oxygen of the atmosphere: that those atoms of carbon of the solid, and those atoms of oxygen of the atmosphere which are within the sphere of mutual attraction unite, and consequently quit their former associate atoms: that by such removal they liberate the latent heat which was contained in the interstices presented by their former union: that such liberated heat follows and unites with the carbon and the oxygen: that together the triple species form a new compound called carbonic acid gas: that the quantity of imponderable atoms of heat united with the ponderable atoms of carbon and oxygen is such, as to render the compound specifically lighter than the atmosphere in which the solid is enveloped, the resulting consequence of which must therefore be, that the carbonic acid gas will evolate from the solid, and the carbon which originally formed a constituent portion of such solid, is thereby abstracted from it.

SOLUBLE, *capable of separation or dissolution.*

The term soluble applies to such solids or parts of a solid, as are truly subject to decomposition in a liquid or gaseous menstruum.

The solid and the menstruum are composed of different species of atoms, united together by attraction of aggregation, in the order and arrangement as induced by the power of affinity subsisting between each, and the total or partial decomposition of the solid; and its amalgamation with the menstruum, is due to the operation of the power of affinity subsisting between the atoms of which the solid and menstruum are composed, causing the derangement and rearrangement of the species of atoms agreeable to the affinity subsisting between each, and thereby forming a new and conjunctive compound with the atoms, or a portion of the atoms of the solid and the menstruum.

All solids or fluids are composed of ponderable and imponderable atoms; and in the case of solids the imponderable atoms are situated in the interstices or spaces presented between the ponderable atoms which are closely united by attraction of cohesion; and in the case of the fluid menstruum the imponderable atoms are intermixed and equably diffused among and throughout the ponderable atoms, which are not closely united by attraction of cohesion; and the imponderable atoms which form a component of either solids or fluids, are subject and liable to egress and ingress from and to the ponderable atoms, as induced by the law of equal diffusion to which they are subject; and such atoms of heat are termed active while in a state of obedience to such law or the law of recession, and latent while the stationary residents of either body.

In the solution of the soluble parts of malted or unmalted grain by the agency of water as the menstruum, and the formation of the compound fluid—wort, it will be sufficient for our purpose to notice, that the classes of atoms which enter into their composition with which we are best acquainted, are five; four of which are ponderable, and one imponderable; the ponderable being denominated oxygen, hydrogen, carbon and nitrogen, and the imponderable caloric or heat. The operation to be effected in the process of solution, is the separation of the ponderable atoms of which the soluble portion of the grain are composed, and which are held closely united by attraction of cohesion, one from the other, and disperse and equably diffuse them among and throughout the ponderable atoms of which the menstruum is composed. To effect such a purpose, the powerful influence of two energetic causes is necessary, and is employed in the operation; the affinity subsisting between the several classes of atoms of which both bodies are composed, and the equable diffusion to which the atoms of heat are subject. In blending two fluid bodies composed of different classes of atoms, and in effecting a new arrangement of the ponderable atoms of each, in conformity to the power of affinity subsisting between each, there is but little difficulty, because none of those atoms are then subject to the law of attraction of cohesion, but are relatively placed in position within the sphere of attraction of aggregation, and are consequently in a state of greater freedom to yield to the influence of any superior operating power to which they may be subjected; and thus we find, that the secondary law of attraction, subsidiary to the primary law of affinity, is sufficient in some cases to cause the separation of atoms previously arranged, and to effect their re-arrangement agreeable to the affinities subsisting between the several classes; and in some cases agitation will facilitate the double process. But in attempting to cause the disunion of the ponderable atoms of a solid which are united by attraction of cohesion, there is a much greater and more difficult work to perform, inasmuch as the power of attraction of cohesion must first be subdued by a superior power, and the subsequent dispersion and re-arrangement of the disunited atoms must be effected; and the power which is usually employed for the purpose is heat, the power of equal diffusion to which heat is subject being superior to the power of attraction of cohesion by which the ponderable atoms are held united, they are separated one from the other by the heat which is transmitted from some body in contact or vicinity, to a greater amount than is sufficient to fill the interstices presented by the union of those spherical ponderable atoms.

By the analysis of grain, we discover that it is composed of four soluble substances, saccharum, fecula, gum and gluten, and that they are divisible into four classes of ponderable atoms—oxygen, hydrogen, carbon and nitrogen; and by the analysis of water, that it is compounded of two classes—oxygen and hydrogen, and a constituent amount of latent heat with each; and if grain is comminuted to the greatest possible extent, with a view to facilitate solution, such a purpose will not be effected by the medium of water at a temperature corresponding with the ordinary temperature of the grain, although the oxygen of the water may have a stronger affinity for the carbon of the grain, than it has for the hydrogen with which it is united; for the carbon being fixed by its combination with other atoms by attraction of cohesion, the impartation of a sufficient quantity of heat from the water to the grain is necessary, to forcibly separate the atoms of carbon from their associate atoms, and render them free to unite with the atoms of oxygen of the water, and which impartation and separation is effected by the power of equal diffusion to which heat is subject; and the art of effecting the solution of the soluble substances of the grain in correct relative proportions, and to a sufficient amount, lies in the administration of water of a proper temperature, and by suitable methods in successive portions.

Upon an inspection of the internal structure of grain, it will be discovered that the four soluble substances of which it is composed, are intimately blended together, yet their identity in such a state of admixture is preserved; and in effecting their solution by water, as much heat must first be imparted to that water as is sufficient to separate the ponderable atoms of which each substance is composed from each other, by the transference of a sufficient quantity of heat from the water to each substance as will separate the ponderable atoms of which they are composed from each other, beyond the sphere of attraction of aggregation as well as cohesion, to which they had before been subject, and thereby enable them to enter into a combination with the ponderable atoms of the water, agreeable to the respective affinities to which the several classes are subject; and in effecting this purpose, the impartation of a definite and discriminating quantity of heat is requisite, to separate and diffuse those ponderable atoms to the proper distance and at a proper speed, so as to enable the combination of the several classes in the order and arrangement of their affinities, instead of causing an heterogeneous arrangement of the ponderable atoms of the several substances composing the grain and the water, resulting in an homogeneous compound of the grain and water, (technically termed the setting of the goods) instead of a distinctive wort separable from the grain, compounded of a solution of a portion of each of the soluble substances of the grain and the water imparted to effect the solution.

To comprehend this subject more clearly, we must consider that the effect of the impartation of heat to water, is to separate the ponderable atoms of which it is composed farther from each other, and that the greater the quantity of heat imparted, the greater must be the distance of their separation up to the point of evaporation, or the limits of the sphere of attraction of aggregation; and that precisely the same effect is produced by the impartation of heat to the soluble substances of grain in the separation of their ponderable atoms. In the next place we should reflect, that if we add water of a high temperature to grain of a low temperature, as much heat will leave the water and pass by transition to the grain as will render both of an equal temperature, and by such transition the ponderable atoms of the water will be drawn closer to each other, by the power of attraction of aggregation, and the ponderable atoms of the grain will be placed farther apart. In this relative position of the ponderable atoms of each, it is evident that they have by such advance towards each other, facilitated and assisted the action of attraction of aggregation between the respective ponderable atoms of the two bodies, and that the power of attraction of aggregation between the associate atoms of each body is diminished; and in administering the quantity of heat to the water which has produced such an effect, the question is, has so much been imparted as will cause the ponderable atoms of the grain to pass the boundaries of the sphere of attraction of aggregation which held them united as an integral body, and to unite with the ponderable atoms of the water and thereby form wort; or whether the ponderable atoms of the water shall pass their line, and unite with the ponderable atoms of the grain, and thereby form an homogeneous and inseparable compound of grain and water; and it becomes a most important point of decision in administering heat to the first mashing menstruum for the solution of the soluble substances of grain, that enough heat and no more is imparted, as will produce by transition from the water to the grain, a separation of the ponderable atoms of each, as will ensure the transfer of the ponderable atoms of the grain to the ponderable atoms of the water, instead of the reverse effect.

From this view of the case, the importance of taking what is called correct mashing heats, or in other words to impart as much heat to the dissolving menstruum as will be sufficient and no more, to cause a separation and diffusion of the ponderable atoms of which the grain is composed, among the ponderable atoms of which the water is composed, will appear evident. And such is the accuracy with which this operation should be performed, so as to ensure the solution of a full amount of the whole of the constituent substances or a relative portion of each, that if an improper heat of the menstruum is chosen in the first stage, no subsequent remedial measures will repair the mischievous results of the first error.

SPECIFIC GRAVITY, *the relative weight of one substance to another.*

The science of hydrostatics is not only exceedingly interesting in many of its details, but a comprehensive knowledge of it often leads to very profitable results, as relates to the practical appropriation of that knowledge in various mechanical arrangements.

The specific gravity of a variety of substances in relation to any standard which may be established by customary and common usage, often furnishes that useful information *a priori* to a practical appropriation of them, as is sufficient to convince the mind of the effects which will result from their use; thus a knowledge of the specific gravity of hydrogen gas or carburetted hydrogen gas in relation to atmospheric air, enables the æronaut to calculate the amount of either which it may be necessary to inject into his balloon, to enable it to float in and ascend through the atmosphere, having previously determined by calculation, &c. the weight of the apparatus and its intended freight. The knowledge also of the weight of a metallic vessel together with its contents of atmospheric air, in relation to an equal bulk of water, enables the previous determination of its capabilities to float upon its surface; and previous to the construction of a metallic vessel for the purpose of flotation, every necessary calculation may be made as relates to the requisite thickness of the metal, its construction and its cubical contents, so that not only its flotation may be ensured, but the additional weight with which it may be loaded without sinking.

The saccharometer, hydrometer and other instruments which are manufactured for the purpose of ascertaining and denoting the specific gravity of various fluids, as compared with the specific gravity of distilled water, are generally composed of metal or glass, both which substances are of much greater specific gravity than the fluids in which they are made to float; and the principle on which either substance is made to float, is by forming a hollow vessel of either material, of such a size and thickness as when filled with air, the united weight of both, together with the appended stems, &c. is less than an equal bulk of water, or the weight of the water which they displace by immersion therein. Thus the saccharometer is generally made of a thin copper spherical or egg shaped vessel, with a brass stem and ball projecting from one point as a counterbalance and weight, to ensure the vertical position of a graduated stem which is affixed to such vessel immediately opposite the lower stem, and which is also formed of brass; and the weight of the whole instrument is so regulated, that it shall float in distilled water at a given temperature, yet immersed to such a depth, as nearly to submerge the entire instrument, minus a small portion of the upper stem; and at such point to which the stem sinks, a line is drawn across and above it is engraved the letter O, and the weight of the whole of the instrument is equal to the weight of the water which that portion of the instrument submerged displaces.

And as relates to the hydrometer, the metallic or glass instrument is constructed on the same principle as the saccharometer; but its weight is so much less, that it will float in alcohol of a great yet definite strength, leaving but a small portion of the upper stem not submerged, and at the point of submersion a line is drawn, and the letter O is engraved above as on the stem of the saccharometer, and the weight of the whole of the instrument is equal to the amount of alcohol displaced by that portion which is submerged.

As wort is heavier than water, and water is heavier than spirit, so it must be evident that if a little extract of malt or sugar is added to the water, and a little water to the alcohol, that either instrument will rise, and their stems stand higher above either fluid; and on the supposition that as much malt extract or sugar, &c. has been added to the water, as will cause a bulk of the resulting compound to weigh one thousand and one pounds, which occupies the same space as a bulk of water which weighs one thousand pounds, then is the specific gravity of such compound said to be 1001, because the specific gravity of distilled water is computed at 1000 as a convenient numeral, and such numeral is rendered the standard of computation; and if another line was drawn on the stem of the saccharometer below the water line and at the point of submersion, the weight of the whole instrument would be found equal to the weight of the compound displaced by such portion of the instrument as was immersed, and the second would denote the specific gravity of such compound in relation to distilled water. And if malt extract, sugar, &c. was continued to be added, an increase of the specific gravity of the compound would be effected, and if performed in the raito of even pounds, and a line drawn on the stem for every pound increase of the specific gravity of the compound agreeable to its increase in weight statically, and the impartation continued until as many lines were drawn upon the stem as might be possible until the whole of the stem floated above the surface of the compound, then would such saccharometer be rendered fit to express the specific gravity of any wort or compound between the scale weight of one thousand pounds of distilled water, and an equal bulk of wort, weighing as many more pounds than such water, as there were lines exhibited upon the stem above the line of flotation. And precisely the same observations apply to the specific gravity of spirit resulting from the addition of water to alcohol, and indicated by the hydrometer, as those which have been offered relative to the indications of the saccharometer, only that the former indicates the less amount of the specific gravity of spirit than water, or its greater amount of specific gravity than alcohol; and the latter, the greater amount of the specific gravity of wort, &c. than water. But in thus pointing out how the saccharometer and hydrometer may be made to indicate the specific gravity of wort in relation to distilled water, or spirit to alcohol, both at a numeral of 1000, it is not to be inferred, that it is usual to graduate the stems of either in relation to the indication of the specific gravity of either fluid; and I am the more induced to advert to the case, because it is a common and prevalent error to confound the terms specific gravity and density together; and consider them as synonymous, and to state the indications of density as those of specific gravity. And as several authors who have published works upon the subject of brewing, have in their various references to the produce of malt, and the strength of wort, fallen into the common error of stating the indications of density as those of specific gravity, and thereby render the correct term as used by other authors, unintelligible to those who are not able to appreciate the difference in the meaning of the respective terms; we deem it necessary, in order to obviate such an inconvenience, to endeavour to explain the meaning of each term, in order that our readers may be rendered acquainted with the important difference in the indications of each. The meaning of the term specific gravity is as before stated, the particular or relative weight of one body or substance to another. And while contending for the distinctness of the two terms as relates to the indications of the saccharometer and hydrometer, we cannot but admit that they are synonymous as relates to their general meaning, and which most probably has given rise to the term specific gravity when the term density should be used. On reference to the slide rule accompanying Dring and Fage's saccharometer, we find that by its aid in conjunction with the indications of the saccharometer, that both the density and specific gravity of the wort is denoted, and the purport of the use of the former term is to denote the amount of the weight of a barrel of wort above the weight of a barrel of distilled water; and the use of the latter term, to denote the amount of one thousand gallons or any other measure of wort, above the weight of one thousand gallons or any other measure of distilled water. Now from this explanation it is evident, that in both cases the purport of the instrument is to express the relative weight between a barrel of wort and a barrel of water for the use of brewers and others, and the relative weight between a thousand gallons or other quantity of wort and an equal quantity of water for scientific men. And as the term density is sufficiently descriptive and dissimilar to the term specific gravity, and as it was necessary that there should be a separate term provided for the use of each in order to prevent misunderstanding, so is it necessary that authors on the subject of brewing, and brewers in their personal communications, should confine themselves to the term density, in describing the produce of malt, the strength of beer, &c, lest in writing or speaking upon the same subject and using different terms, they fail to comprehend each other.

Previous to the conclusion of this subject, it may perhaps be necessary to state, that the cause of a barrel of wort being of a greater weight than a barrel of water is, because it is composed of a greater amount of ponderable and less amount of imponderable atoms than water, and that as the bulk of each is the same, the ponderable atoms of the wort must be more densely or closely compacted than those of water; and as the ponderable atoms have weight and the imponderable none, so that substance or body which is composed of the greatest number of ponderable and the least number of imponderable atoms will weigh the most, and its ponderable atoms must consequently be more densely compacted; and hence the term density is used as both illustratively and expressively distinct from the term specific gravity.

SPIRIT, ***an inflammable fluid, produced by the fermentation of vinous fluids, and separated from them by distillation.***

A very numerous class of vegetable substances are capable of furnishing spirit, by a solution of their component soluble substances, by a vinous fermentation of the compound fluid resulting from such solution, and by a separation of the spirit from the fermented fluid by distillation.

In the formation of spirit in the process of fermentation, the effect is produced by the impartation of oxygen to the vinous fluid from the atmosphere, which unites with a portion of the carbon of the fluid, and forms carbonic acid, and which carbonic acid is converted into gas of less specific gravity than the atmosphere, by the union of a sufficient portion of heat with it, and which heat is derived from the vinous fluid itself, by a liberation of the latent heat of the air and of the fluid, rendered active by an abstraction of the ponderable atoms of oxygen from the air and of carbon from the fluid, and which heat combines with the new formed substance as a necessary constituent of the compound: carbonic acid gas being lighter than the atmosphere, evolates from the fluid, and the carbon thereby abstracted, no longer prevents the necessary union between other portions of oxygen from the atmosphere and the hydrogen of the fluid, the result of which is the formation of spirit.

The spirit which is formed in a fermented fluid, is intimately blended with and extensively diffused throughout such fluid, and may be separated from it in two ways—by the process of freezing and evaporation. The former process is effected by the abstraction of heat, and the latter by its impartation.

By a congelation of the aqueous portion of a fermented fluid, which includes the solidification of the extractive matter combined with it, the spirit diffused among it is concentrated, and is collected in one central mass; and not being congealed, may be separated in a fluid state from the congelated portion of the fluid. The cause of the congelation of the aqueous portion of the fermented fluid, and not the spirituous, is to be attributed to the difference in the temperature of fluidity of the two substances.

By the temperature of fluidity of any liquid, we are to understand the amount of the imponderable atoms of heat mixed with the ponderable atoms of which the fluid is composed, and which together constitute it an integral and specific fluid, in conformity with the several atomic laws: thus a definite number of ponderable atoms of the several classes which enter into the composition of alcohol, require a definite amount of the imponderable atoms of heat, agreeable to a prescribed law to which those atoms are subject; and again, a definite number of the ponderable atoms of the several classes which enter into the composition of water, and which require a definite amount of the imponderable atoms of heat, agreeable to a prescribed law to which those atoms are subject; and it is this amount of heat appertaining to each, which is denominated its temperature of fluidity: and from which designation we are to understand, that if the whole of such heat was abstracted from the ponderable atoms of either fluid, then would the latter be united by attraction of cohesion and form solids, being impelled thereto by the attraction of aggregation subsisting between the ponderable atoms, and not being prevented by the opposing presence of heat. From this view of the subject we may infer, that as alcohol is composed of a less number of ponderable, and a greater number of imponderable atoms than an equal quantity of water, so its temperature of fluidity is much greater; and in the process of congelation, or the abstraction of heat from either fluid, until their ponderable atoms cohere together, either a much larger amount of heat must be withdrawn from the alcohol than from the water, in the same space of time by the abstracting medium, to effect the congelation of the alcohol; or more time, and an abstracting medium of a sufficiently low temperature must be allowed and administered, to effect the congelation of the alcohol.

To the difference in the temperature of fluidity between alcohol and water, may also be attributed the difference in the specific gravity of the two fluids.

The separation of spirit from a vinous fluid by the process of congelation, is by no means a customary or advantageous method.

The separation of spirit from a vinous fluid by evaporation, will be found fully treated of under the heads of "Distillation," "Rectification," "Still," &c.

The purity of spirit as obtained by distillation, depends much on the purity of the vinous fluid from which it is separated, the chemical measures which are adopted to prevent the evaporation of the impurities in conjunction with the spirit, the efficiency of the still to facilitate the separation, and the number of distillations to which it is subject; and its purity is commonly determined by the taste and smell.

The strength of spirit (as it is usually termed) may be determined either by the statical or hydrostatic weight, from a comparison in either case of its specific gravity with an equal bulk of distilled water, or alcohol of a definite standard strength.

SPONTANEOUS, *voluntary, free, unimpelled.*

The term spontaneous is generally applied to some chemical action which occurs without an apparent cause, such as ignition, fermentation, &c.

That which may be termed a natural ignition, is the result of placing in contact with, or in the vicinity of a combustible substance, another substance which is previously in a state of incandescent combustion; and with such an operation and the resulting effect, we connect the idea of its being a natural ignition, because by common observation we are conversant with the practice; but there is nothing more natural in the effect resulting from such a cause, than in the inflammable combustion of two or more substances when intermixed, in contact or vicinity, between the several component classes of atoms of which there is an affinity and attraction, causing a decomposition of the bodies thus united, a liberation of their constituent heat and light, and a consequent ignition or bursting into flame.

The lamentable instances of deflagration which too often occur from what is termed spontaneous combustion, afford a powerful evidence in favor of a general diffusion of chemical knowledge, a more extensive analysis of substances subject to inflammable combustion, and a more extended information of their classified atomic composition; and in addition a clear and perspicuous digest of the laws of affinity and attraction subsisting between the several classes of atoms of which they are composed, and the amount of their constituent heat and light, in order that such knowledge might induce an avoidance of the intermixture, or the placing in contact or vicinity, those substances which are liable to spontaneous ignition and combustion.

As the result of spontaneous or purposely effected ignition, is an evolation of heat and light from the substance in a state of combustion, so those inflammable bodies which possess the greatest amount of the atoms of heat and light as constituent principles, are the most liable to spontaneous ignition, provided there is a powerful affinity subsisting between the ponderable atoms of which two or more such substances intermixed, in contact or vicinity, are composed; and it is much to be regretted, that those experimental and practical chemists, who have favored the public with statements of the classes, and the respective amount of the ponderable atoms of each class of which a variety of substances are composed, have altogether omitted to state or allude to the classes and amount of the imponderable atoms, which form a portion of the constituent atoms of which they are composed; and should such an omission be the result of an imperception of the importance of a cognizance of the number and name of the classes, and their respective amounts, we have to regret the absence of such perception; and if of an inability to ascertain their number, name and amount, we have the accomplishment of the discovery, as one among the many desideratæ, which chemical science has yet to supply.

It is usual also to apply the term spontaneous to that species of fermentation, whether vinous, acetous or putrefactive, which occurs to a fermentable substance, without the impartation of some peculiar ferment, which is capable of producing those results; and the term natural to that which occurs as the result of the impartation of some well known ferment which is capable of producing a well known result; and thus if we impart sound yeast to wort, and find that a vinous fermentation is the result, we term it a natural fermentation; or if we impart sour yeast, and find that the result is an acetous fermentation, still we say it is a natural fermentation; and to proceed a step further, if we impart putrid yeast, and experience a putrefactive fermentation, still we say it is natural, because as we sow, so do we expect to reap. But if we impart no yeast or other ferment, and a vinous, vino-acetous, acetous, vino-putrefactive or putrefactive fermentation occurs to such fermentable fluid, then we say it is a spontaneous fermentation, because it is the result of an imperceptible cause, although the cause may be well known to those who are well versed in the science of chemistry, yet to those who are not, it may appear both unnatural and unaccountable.

The cause of what is termed a spontaneous vinous fermentation to several fermentable fluids, is the presence of a vegetable ferment abstracted from the fruit or vegetable, which nature has provided and secreted in organic vessels purposely for the production of such an effect, and no result can be more truly natural than such as occurs from such a cause.

The cause of what is termed a spontaneous vino-acetous fermentation, is the impartation of oxygen to the fermentable fluid from the atmosphere, and its combination with a definite portion of carbon, thereby forming carbonic acid, and a definite amount of carbon and hydrogen, thereby forming acetous acid, and such combination is the result of an affinity subsisting between the oxygen combined with the atmosphere in a state of simple mixture, and the carbon and hydrogen of the fermentable fluid, and the consequent union of all such oxygen with the carbon and hydrogen, as may float within the sphere of attraction of such carbon and hydrogen.

The cause of what is termed a spontaneous or artificial acetous fermentation, is the impartation of such oxygen as may be in a state of simple mixture with the atmosphere, and which may be floating therein within the sphere of attraction of the carbon and hydrogen of the fermentable fluid, and its combination therewith, and a consequent formation of acetous or acetic acid; and the continual state of a fermented fluid to render it susceptible of an acetous fermentation, is the abstraction of a considerable amount of the carbon it originally possessed, before it is submitted to the process of natural or artificial acetification; and hence it is customary to submit such fermentable fluids as are intended to undergo an acetous fermentation, to a previous and powerful vinous fermentation, for the purpose of abstracting as much carbon therefrom as is possible, in the form of carbonic acid gas, and the greater the extent to which such an abstraction can be effected, the better is the state and condition of the fluid to undergo the subsequent process of acetification.

The cause of what is termed a spontaneous or artificial putrefactive fermentation, is the impartation of a putrescent fermentative substance by insertion, or by abstraction from the vessel in which such fluid may be placed; and the result of such impartation or abstraction is the formation of a new compound, and in which the presence of nitrogen furnishes the characteristic property of putridity. That which is termed a spontaneous putrefactive fermentation, invariably succeeds an acetous fermentation, provided artificial means are not adopted to prevent a transition from one process to the other previous or subsequent to the termination of the acetous process.

The addition of a putrescent gaseous ferment, or putrescent fermentative substance, to a fermentable or fermented fluid, are not the only methods by which a putrefactive fermentation will be ensured, but the abstraction or non-impartation of oxygen from or to a fermentable or fermented fluid from the atmosphere, will cause a putrefactive fermentation to occur. And this fact may be ascertained by exposing vinegar to the atmosphere, when it will be discovered that the whole of the oxygen will be gradually abstracted, provided the process of impartation has been completed to the extent of capability of the fluid to receive it, the limit to which extent is the presence of carbon in the fluid to unite with it; and as soon as such oxygen is entirely abstracted, a putrefactive fermentation will gradually follow. That a putrefactive fermentation will result from the non-impartation of oxygen to a fermentable or fermented fluid, may be ascertained by exposing such fluids to the atmosphere, suspending a piece of zinc therein, when it will be found that in consequence of the zinc preventing the combination of the oxygen of the atmosphere with the fluid, a putrefactive fermentation will ensue.

STARCH, *a component substance of farinaceous grain.*

Every species of farinaceous grain possesses the elementary principles for the formation of fecula or starch, but what is termed the ripening process is requisite for its ultimate formation.

In the formation of grain by the process of vegetation, the various substances of which it is ultimately composed, (provided the process has been correctly conducted to the point of maturity) are gluten, gum, fecula or starch, and saccharum; and the formation of the whole of these substances, is the result of an accretion of atoms from the sap which passes by circulation from the root to the stalk, and from the stalk to the grain; and by the abstraction of the superfluous atoms as relates to accretion, yet requisite as relates to a conveying medium, and their ultimate transition from the grain to the atmosphere by gaseous transpiration.

The first effort of nature in the formation of grain, appears to be the creation of gluten by accretion; the second effort, the creation of fecula by an abstraction from gluten; and the third effort, by an impartation to fecula for the formation of gum and saccharum.

As the fluidity of the sap is necessary to enable it to circulate, so its component atoms are in much greater abundance than is necessary for the purpose of a supply of atoms by accretion to the grain for its formation, and hence an immense quantity of sap passes by circulation through the grain before its formation is completed by the gradual accretion of atoms therefrom; and it must be obvious, that as nature does nothing in vain, therefore as soon as the formation of the grain is complete, the sap must cease to flow, and that which is left, having fulfilled its office, as a conveying medium needs a subsequent abstraction. As soon therefore as the formation of the grain is completed, the ripening process commences, which consists in the slow and gradual abstraction of the stagnant sap by transpiration to the atmosphere, and the formation of fecula, gum, and a small portion of saccharum, by an impartation of heat and oxygen from the atmosphere. The formation of saccharum in grain by the ripening process is conditional, and dependent on the extent to which such process is conducted, and the successful performance of it; and the impartation of heat and oxygen from the atmosphere in sufficient abundance, and for a sufficient period, is necessary to the favorable accomplishment. The purport of the impartation of heat and oxygen is twofold; first, for the formation of carbonic acid gas, by their union with a definite quantity of carbon, for the subsequent purpose of abstracting it from the grain by transpiration; and second, for the purpose of causing the formation of fecula, gum, and saccharum, by the union of oxygen with definite amounts of carbon and hydrogen. In this operation the oxygen acts as a principle and the heat as an agent. The oxygen combines with the carbon of the grain, as the result of an affinity subsisting between the two species of atoms, and as effected by the power of attraction to which both are subject, when placed in proximity to a definite distance from each other, and their consequent union proves the production of carbonic acid.

But as the formation of such acid within the grain, and its permanent residence there is not the ultimate purpose of nature, she causes the addition of as much heat thereto, as is necessary to convert it into carbonic acid gas of a less specific gravity than the atmosphere, in order that it may leave the grain by evolation; and it is the province of heat as an agent to furnish the needful supply of oxygen for the purpose to the atmosphere, by causing its transpiration from the leaves of trees and other sources, to facilitate its access to the grain and its combination with the carbon, and also to unite with both as a constituent portion, in order to the formation of a gaseous compound.

In contemplating the accomplishment of these operations, we plainly perceive the need of an unclouded sun, and its suitable proximity to that portion of the earth, on the surface of which the ripening of the grain is required to be performed, inasmuch as an extraordinary supply of heat for the occasion is requisite, to accomplish the purpose effectively and advantageously in a very short period of time. The absence of rain is also desirable, as the impartation of moisture is adverse to the process of ripening—an essential portion of which consists in the abstraction of the residue of the sap, which remains upon the cessation of the accretion of its atoms to the grain, and the consequent cessation of its circulation.

A light dry soil is also conducive to the prompt and effective ripening of grain; for as the earth is the receptive and retentive substance of water, and a variety of fertilizing materials which are committed to it, for the formation of that sap which is needed as nutriment for the growth of grain, so that soil which retains no more moisture than is sufficient for the purpose, and which scantily supplies it in the last stage of the accretion of its atoms to the grain, and ceases to supply when it is no longer needed, is much the best adapted to facilitate and accelerate the ripening process.

Grain grown on a wet and heavy soil, is characterised by the presence of much gluten, and a small amount of fecula in its composition; and however well the process of growth may have been performed, the great probability is, that the ripening process will be incomplete.

The presence of much gluten is denoted by a horn-like texture and color of its interior; and of much fecula, by a chalk-like texture and color of its internal structure.

Grain possessing much gluten is in a very unsuitable condition for malting, but in the hands of a skilful maltster is convertible into good malt, as he will artificially finish the ripening process in the malthouse, which had much better have been performed if possible in the field—converting a portion of the gluten into fecula previous to steeping, and so regulating the steeping and the subsequent process of germination, as ultimately to produce good malt, with an extra amount of care, skill and toil.

STEAM, *the vapour which evolates from hot fluids.*

All fluids, whether liquid, vapourous, ærial or gaseous, are compounded of two or more classes of ponderable atoms, and one or more classes of imponderable atoms.

The ponderable atoms composing ice, water and steam, are precisely the same as to class and the proportion of each, but not so as relates to the proportion of the imponderable atoms.

As simplicity is conducive to illustration, we will confine ourselves to the supposition, that ice, water and steam, are compounded of precisely the same amount and proportion of the ponderable atoms of oxygen and hydrogen, but of varying proportions of the imponderable atoms of heat; and that by this arrangement, either body is transmutable into the other by the addition or abstraction of heat as may be requisite.

The production of steam from water, and its appropriation as a motive power, or as an impartive medium of heat, are subjects of vital importance in a mercantile point of view, and we propose to confine our attention to a review of the elementary principles of each.

The general mode of producing steam to serve as a motive power, or as a medium of the impartation of heat to some distant body or substance, consists in the charging of a metal vessel from one half to three fourths full with water, which vessel termed the boiler, is nearly imbedded in brick work over a furnace, the flue of which extends in height around the sides of the boiler, nearly to the water line, or that point to which it is intended the boiler should be kept constantly charged, during the whole period of the generation of steam for any specific purpose, the space above the water line being reserved as a reservoir for the steam generated. The purport of limiting the height of the flue to a short distance below the water line, is that no more heat may be imparted to the boiler, than the water is capable of receiving; and the purport of keeping the boiler constantly charged up to the water line is, that the whole of the heat imparted to the boiler, may find a recipient within in the water with which it is kept constantly supplied: and the purport of constructing the flue round the sides of the boiler, is to present as large a surface of metal as is possible, consistent with the several other arrangements for the reception of heat from the burning fuel, and the impartation of it to the water within the boiler; and all the mechanical arrangements in the formation and fixing the boiler, and the construction of the furnace, flues, &c. should be effected upon the best principles with a view to the generation of heat and its subsequent impartation to the water in the boiler, upon the most economical and advantageous terms. And supposing this to be done, we will next examine the principle of generating heat in the furnace; and we find that the fuel being ignited, its combustion is supported and continued by the access of atmospheric air to it, which passes through the ash pit and between the furnace bars, and coming in contact with the incandescent fuel, as much heat is imparted to it as is sufficient to separate the ponderable atoms of which it is composed beyond the sphere of mutual attraction, and consequently the constituent atoms of oxygen of such air unite with the constituent atoms of the carbon of the fuel, between which there is a powerful affinity, and they together form carbonic acid; and an impartation of heat to such carbonic acid occurring from the decomposed fuel and air, it is converted into carbonic acid gas of less specific gravity than the atmosphere, and therefore evolates and passes off by the flue and chimney with the nitrogen, which previously formed a constituent portion of such air. In this process of combustion, the decomposition of the fuel and a large amount of atmospheric air is effected, and as both the fuel and air are compounded of a large proportion of heat, which heat is latent while forming a constituent portion of either body, but free the moment of the dissolution of either as integral bodies, so such constituent heat being liberated, is rendered ready for its impartation to other bodies; and we have next to review the principle of impartation by which such heat is transmitted from the furnace to the boiler, and from the boiler to the water within it. Heat in a state of freedom is subject to two laws, a primary and secondary—the primary termed equal diffusion, and the secondary recession from the centre of the earth, or gravitation toward the centre of the sun. The heat liberated from the decomposed fuel and air, traverses the bottom and sides of the boiler in its passage from the furnace through the flue to the chimney, and if not traversing the surface of such portion of the boiler to which it has access too rapidly, the whole of the heat may be imparted to the boiler in obedience to the law of equal diffusion; but if passing more rapidly or in greater abundance than can pass by transition to the boiler in obedience to such law, then a portion of such heat will find its way to the chimney in obedience to the secondary law, the law of recession, and thereby be lost to the purpose for which it was rendered free. The heat which is thus transferred from the burning fuel to the boiler, induced by the law of equal diffusion, the gases emanating therefrom being of a much higher temperature than the boiler, is transmitted from the boiler to the water within, in odedience to the primary law; the temperature of the boiler being higher than that of the water, and the heat thus transferred to the water, ascends to its upper surface in obedience to the secondary law, the law of recession; and thus the first portion of heat imparted to the water, although received at its lowest surface ascends to the upper, and the temperature of the upper surface becomes greater than the lower. The decomposition of fuel and air, and the impartation of the resulting liberated heat continuing, the temperature of the upper surface of the water soon amounts to 212 degrees, when the formation of steam commences: and the safety and eduction valves of the boiler being closed, the steam which is generated on the upper surface of the water evolates, and the generation and evolation continuing, the space above the surface of the water would soon be filled with steam, was it not already filled with air; but as such air is elastic, the volume is compressed into a smaller space by the expulsion of a portion of its constituent heat through the metal composing the top of the boiler, and the boiler being so charged with heated water, steam, and condensed air, we will suppose that either the safety or eduction valve is opened and the air rushes out, leaving the boiler charged with water and steam only, the valve being again shut. We will next suppose that the temperature of the water from the upper to the lower surface, has attained to about 212 degrees or boiling heat, and the boiler being completely full of water and steam, the question is, can any more heat be imparted to either water or steam? we think not, because the receptive capacity of either water or steam for heat is not to a greater amount than about 212 degrees, and because no addition can be made to a plenum. But it is said that steam is compressible and expansive, and that in these two properties consists the accumulation and the exercise of the motive power with which it is endued, and that the amount of the power generated is proportionate to the extent of the compression; and hence we hear of the generation of steam, and its compression within the boiler to such an extent as to cause its pressure upon the internal surface of the boiler to be equal to the pressure of so many atmospheres; but we are decidedly of opinion that steam is neither compressible nor expansive, (unless in a vaccuum) and although a volume of steam may be evolved from a boiler, and occupy a tenfold space subsequent to its liberation than it possibly could in the boiler, yet that is by no means a confirmation to us that steam is either compressible or expansive; and we deem that the proofs offered in favor of the doctrine of its compressibility or expansibility are diametrically opposed to the possibility of the occurrence of either, and to all the well known results, which ensue from the impartation and abstraction of heat. If we ask what is the effect of the impartation of heat to water, we are told to cause its expansion or increase in bulk, until its diminution commences by the generation of steam, and its evolation from the surface of the water; and we are told that if the impartation is continued, that the boiler will eventually be filled with water and steam, and up to the point of repletion expansion has been the result of the impartation of heat; and then it is endeavoured to convince us, that by a yet further impartation of heat, that a compression or diminution of the steam which first occupied the whole space within the boiler above the water is effected by the production of more steam by heat subsequently imparted; but to suppose that heat can cause both the expansion and contraction of a fluid appears to us to be impossible, and not supported or countenanced by any analogous proofs; for if we examine the resulting effects of the condensation of atmospheric air, we find that heat is evolved and not imparted in the process, and that it is only by the expulsion of a portion of the constituent heat, that the ponderable atoms can be brought closer together, and thereby cause its volume to be reduced in bulk. It will then perhaps be asked, to what do we attribute the increase of power furnished to steam by the impartation of heat in the ratio of the amount imparted, and to the production of a greater amount of steam than the space within the boiler above the water could possibly contain without compression, or a diminution of its bulk, and its subsequent expansion or increase of its bulk, which it experiences on its liberation from the boiler, and also the cause of the bursting of the boiler, in case the steam is not liberated previous to the generation of such an amount and its compression to such an extent, as to cause an internal pressure upon the boiler which it is unable to bear? To which our reply is, that we conceive that the formation of more steam than the space above the water within the boiler will contain is impossible previous to its exit; that the compression and expansion is apparent and not real; that an accumulation of heat in the metal of the boiler and its appendages, and in the surrounding brick work and atmosphere, occurs in consequence of the inability of either water or steam to receive more heat; that the heat accumulated in the boiler and the surrounding media, presses upon the water and steam within the boiler in virtue of the law of equal diffusion, with a power and force proportionate to the extent of endowment conferred upon it by such law, and the difference in the amount of the heat accumulated and communicable, and the amount possessed by the water and steam within the boiler; that the pressure upon the internal surface of the boiler is a reverberating, reflective or recoiling pressure, resulting from the pressure of heat upon the water and steam, in its endeavour to force its admission into the water and steam in obedience to the law of equal diffusion, and not an expansive force exerted by an increase in the bulk of either water or steam, beyond their receptive capacities for heat; that between the impulsive power of heat, which may be compared to a power operating upon a lever, and the resisting power of the water and steam, which may be compared to a weight to be raised by such imaginary lever, the sustaining boiler may be compared to the fulcrum of such lever, and which if not of sufficient strength to sustain the force of pressure exerted upon it by the impulsive and resisting powers, its disruption necessarily ensues. We conceive also that the amount of the the motive power of steam which is generated within the boiler, previous to its bursting, or its exit by the safety or eduction valves, is no more than the difference between its specific gravity and that of the surrounding atmosphere—a difference so slight as will be found very far inferior to account for the rapidity and force of its exit; but we attribute all the acquired force to the formation of an additional quantity of steam subsequent to the bursting of the boiler, or the opening of the safety or eduction valves, by the very rapid transition of the accumulated heat in the boiler and surrounding media to the water within the boiler, as soon as the first amount generated has made its exit, and that the apparent expansion of a large amount of steam compressed into a small space previous to its exit from the boiler, is but the rapid formation of a large additional quantity, subsequent to the liberation of the first amount created.

We admit of the expansibility of steam within the cylinder of the steam engine, resulting from the creation of a vacuum therein by the ascent or descent of the piston, and the consequent absence of atmospheric air, which if present would keep the constituent atoms of steam within their ordinary limits; but such expansion is not the effect of an innate power impelling its constituent atoms to occupy a greater space, but of the removal or absence of a restraining power which under customary circumstances, circumscribes the limits of the space which steam can occupy; and hence such expansion is unproductive of impulsive power.

If then the theorem which we have advanced is correct, it appears to us that the liability to burst, to which a steam boiler is subject, is due to several causes. We conceive that no created substance is able to resist the diffusive power of heat, and that such diffusive power is proportionate in amount to the difference between the temperature of the impartive and receptive medium. That the accumulation of heat in the metal of the boiler, beyond the receptive capacity of the water and steam within the boiler, causes a recoiling force or pressure upon the surface of the metal of the boiler, proportionate in power to the amount of heat accumulated. That the heat which is thus imparted to the metal composing the boiler and retained by it, separates the ponderable atoms of which it is composed farther from each other, and thereby diminishes the force of attraction of cohesion and aggregation which holds those atoms united, to an extent proportionate to the amount of heat imparted and retained, and the consequent separation to which its ponderable atoms are subject; and that as what is termed the strength or tenuity of the metal is dependant upon the force of the power of attraction of cohesion and aggregation by which those ponderable atoms are held united together, so in proportion to the amount of heat imparted and retained must be the distance of removal of those ponderable atoms from each other, and the consequent diminution of the force and power of the attraction of cohesion and aggregation subsisting between those atoms, and the resulting diminution in the strength or tenuity of the metal.

In the generation of steam as a motive power, the purport is not merely to render a portion of the water of less specific gravity than the atmosphere, by the impartation of as much heat as will separate its ponderable atoms so far apart, as to occupy such a space as will render the whole of less weight than the bulk of atmospheric air which they together have displaced, and thereby enable the new compound called steam, merely to evolate from the surface of the water which supplied the ponderable atoms as a principle, and the imponderable as an agent; but the purport, in addition, is to generate an impulsive as well as an evolating power, and to invest steam with it, in order that it may accomplish the several purposes for which it is created. If steam is generated to an amount just sufficient to occupy the space between the water within the boiler and its upper portion, and the safety and eduction valves are closed, and the temperature of the water and steam within the boiler, and the metal composing the boiler, are at 212 degrees of heat, and no more heat is imparted, and the safety or eduction valves are then opened, it will be found that the steam which has been generated will evolate from the boiler with as much force as will be induced by the amount of the difference in the specific gravity of such steam, and the superincumbent atmosphere; but such force will not furnish a motive power adequate to the need of any mechanical operation; and if the safety or eduction valves were allowed to continue open, and the impartation of heat was continued, so as to generate steam with a rapidity no greater than such steam could be evolved from the valve without impediment or restraint, we might cause the whole of the water in the boiler to evaporate, without furnishing a motive power to an adequate amount, and during the process up to its termination, we should find that the temperature of the water, steam, or boiler, never exceeded about 212 degrees; but if we generate steam faster than it can pass such safety or eduction valves free from restraint, we still find that the water and steam continue at the same temperature, but that in the same given period of time, a much larger amount of steam passes by such valve, and consequently with a much greater degree of force than it had previously passed, and thereby an available motive power is furnished. Such being the case, we therefore conclude, that in order to invest steam with a motive power, it must be generated faster in the steam compartment of the boiler, than it can pass free and unrestricted by the safety or eduction valves; that the smaller the orifices are which such valves cover, the greater will be the force with which the steam will pass through them; and the force with which the steam generated will pass, will be proportionate to the difference in the amount created, which would pass in virtue of its lesser specific gravity than the atmosphere, and which will be able to pass impulsively. And what is the impulsive power? The heat imparted from the fuel to the boiler, and from the boiler to the water. But it is said, that neither water nor steam can receive any more heat after it has attained to the thermometric temperature of about 212 degrees; and if neither can receive any more heat, how then can the heat imparted to the boiler, and which cannot be received by the water within the boiler, or the steam already generated, impart an impulsive power to such steam as issues from the orifice of the safety or eduction valves? The reply to which is, that if heat is imparted to the boiler faster than the water can receive it, the surplus quantity will be accumulated and retained by the metal composing the boiler, and such heat will press upon the steam already generated, with a force proportionate to the amount accumulated, multiplied by the power of equal diffusion to which such heat is subject; and should the amount thus accumulated so far diminish the tenuity of the metal, and increase the recoiling pressure upon the internal surface of the boiler as to exceed its ability to bear it, its disruption must then necessarily occur.

We have already observed, that it is usual to charge a steam boiler in the first instance with water to a definite height, and that it is usual to endeavour to regulate the supply of water to the boiler during the process of the generation of steam to an amount, and with a rapidity proportionate to its consumption in such creation, so as that its depth shall not exceed or fall short of such point which is called the water line; and that the height of the furnace flue around the sides of the boiler, is but little short of such water line, and that the purport of such arrangement is to endeavour to cause the impartation of as much of the heat as is furnished by the fuel to the boiler as can possibly be effected, and to impart no more than the water within can receive; and hence it necessarily follows that if the supply of water to the boiler is not sufficient to cover any portion of that part which is exposed to the action of the fire within the flue, and that the accumulation of heat will occur in the metal which is thus exposed, and the impartation being above the water, such heat will in obedience to the laws of equal diffusion and recession, rapidly ascend and become diffused throughout the entire surface of the boiler, and gradually accumulate to the amount of disruption of the boiler, provided the impartation of heat is continued, and its subsequent abstraction is not effected. And it should be well understood, that a subsequent abstraction may become a dangerous remedy if injudiciously administered, for if instead of diminishing the supply of heat, and allowing the escape of the surplus heat accumulated in the boiler by gradual radiation, a large amount of water is injected into the boiler to raise the supply to the water line, and such water is cold and too rapidly injected, the probable result will be the disruption of the boiler, by the too rapid increase of the amount of difference between the temperature of the boiler and the water, thereby increasing the amount of the power of equal diffusion to which the heat in the boiler is subject, causing a consequent greater recoiling pressure upon the boiler.

It is the opinion of some, that one of the causes of the bursting of steam boilers, is the decomposition of the water within by its primary conversion into steam, and a subsequent decomposition of such steam, a combination of the oxygen of the water with the metal composing the boiler, leaving its hydrogen subject to ignition by the highly heated metal, and that the disruption of the boiler is to be attributed to the explosive decomposition of such hydrogen; but without questioning the possibility of such an occurrence in a wrought iron boiler, we very much doubt the probability of it.

The following summary list of causes or means by which the disruption of a steam boiler may be effected, we conceive may be useful.

To charge a boiler full with cold water; to load the safety valve with a weight greater than the cohesive strength or tenuity of the metal of which such boiler is composed; to shut the eduction valve, and then to impart heat to such water by medium of the metal of the boiler, to a sufficient amount to cause disruption, and probably to a much less amount than is sufficient to raise the temperature of such water to 212 degrees.

To charge a boiler to the usual water line, load the safety valve as before, shut the eduction valve, and impart heat, and disruption will probably occur, before the lower surface of the water in the boiler has attained to the temperature of 212 degrees.

To properly charge the boiler to the water line, and continue the supply to such point, neither above nor below, during the whole process of the generation of steam, and impart heat to the boiler more rapidly than the water within can receive it, and to an amount in accumulation in the metal composing the boiler sufficient to diminish its tenuity to a disruptive extent, in conjunction with the recoiling pressure of the heat accumulated upon the internal surface of the boiler; the safety valve being at the same time properly loaded, and the eduction valve opened and shut at an unrestricted speed of the engine.

To properly charge the boiler to the water line, to reduce the charge below the water line during the process of the generation of steam by insufficient injection, and thereby increase the area of the steam compartment; to impart heat to the boiler with a rapidity, and to an amount perfectly safe and proper, with the boiler charged and kept charged to the water line, but owing to the increased area of the steam compartment, and the diminished area of the water compartment, the accumulation of heat in the boiler beyond the receptive capacity for heat of the water and steam may be such as to cause the disruption of the boiler, although the safety valve may be properly loaded and the eduction valve opened sufficiently frequent.

To overload the safety valve; the accidental adherence of the safety valve; the irregular or inefficient opening of the eduction valve; the irregular or insufficient reception of steam by the cylinder of the engine; an accidental or designed overloading of the engine, or an endeavour to cause it to perform more work than it is able to accomplish, thereby causing a diminished consumption of steam and a consequent reactive pressure of the steam upon the boiler; an accretion of calcareous earth by deposition from the water to the internal surface of the boiler, the consequent additional impediment presented to the rapid transition of heat from the boiler to the water, and the resulting accumulation of heat in the metal and accreting substance; the liability of such calcareous coating being separated in portions from the surface of the boiler by the effect termed blistering, and the transmission of heat from such part of the boiler to the water being nearly suspended, an accumulation of heat in the metal may occur to the extent of its disruption. These, and most probably other causes which do not at present offer themselves to our memory, may severally or conjunctively effect the bursting of steam boilers.

We have stated that the capacity of both water and steam for thermometric heat does not exceed about 212 degrees, and it may be here necessary to explain, that although the thermometric temperature of steam does not exceed that of water, yet that its constituent amount of heat far exceeds that of water, and that in the conversion of water into steam, it is not only necessary first to raise the temperature of water to about 212 degrees of thermometric heat, but to impart a large additional quantity of heat to such water to convert it into steam, and that the cause which prevents such additional quantity from passing by transition to the mercury of the thermometer, is because such heat becomes latent in virtue of its constituency, and is therefore not subject to the law of equal diffusion to any body which may have attained to its own thermometric temperature. In the generation of steam for the purpose of imparting heat to the other bodies or substances, should they be situated at some distance from the steam boiler, it is necessary that such steam should be furnished with a motive power to enable it to reach its destination, and it is necessary that the conveying pipes should be covered with some non-conducting heat material, in order to prevent an unnecessary diminution of that motive power, and a loss of valuable heat by abstraction in its passage, and it will be found that an abstraction of the constituent heat of such steam by any body or substance will be accomplished, while the abstracting substance is of a lower thermometric temperature than about 212 degrees.

STILL, *a vessel and appendages for the purpose of distillation.*

The principle of construction of the ancient stills—the crane neck, and the alembic, have within the last few years been discovered to be inadequate to the production of spirit of sufficient purity to satisfy the public taste, and with that economy of obtainment as is conducive to the interests of the distiller and rectifier; and hence the attention of scientific men has been directed to the subject, and a variety of essential and important improvements have been effected in the construction of stills, and the connecting condensing apparatus.

Proceeding systematically with the necessary enquiries in order to discover the defects of those stills, and the connecting condensing apparatus—the worm and worm tub, and the productive results; the replies consecutively presented are, the admixture of a large amount of aqueous, oleaginous, acetic and mephitic vapours with the alcoholic, their passage together over the helm to the condensing worm, and through the latter to the receiver as a low wine, or weak and very impure spirit, instead of a very strong and comparatively pure spirit, involving the necessity of one or more distillations for the production of spirit of a marketable strength and purity.

The production of a very large quantity of impure faints. The necessity of an agitating apparatus to a wash still, to prevent the liability of the adhesion of the undecomposed extract from the grain to the bottom and sides of the still, such liability resulting from the large amount of aqueous vapour passing the helm with the alcoholic, and thereby leaving the extract not sufficiently diluted as to prevent such adhesion, and the consequent burning of such extract, causing the gaseous products of the destructive distillation of such extract to rise and mix with the alcoholic vapour, and to impart to the spirit in the receiver an empyreumatic flavor. The cost of the motive power to work the agitator; the cost of the resulting wear and tear; the liability of the derangement of such apparatus and the connecting machinery, and its first cost; the impediment of such apparatus to cleanliness and the increased labour to effect it; the unnecessary large consumption of fuel upon every distillation resulting from the carrying over so much aqueous and other vapours with the alcoholic; the loss of spirit by waste, the loss of time, the cost of extra labour, and the additional danger attendant upon every superfluous distillation; the liability to experience the various evils consequent upon over firing, such as the waste of uncondensed alcoholic vapour, the loss of such vapour by escape through strain created crevices, the loss of spirit by evaporation in the receiver, in consequence of the spirit coming over too hot through the condenser, the danger of the bursting, collapsing, or blowing off the head of the still, the consequent waste of spirit, the liability of deflagration, and all the disastrous consequences; the unnecessarily large amount of condensing water required, the size of the vessel to contain it, the worm within it, the room in which to place it, and the superfluous cost of the whole apparatus and building to contain it; and a few more evils which might probably be adduced, but which memory fails to furnish, and which the reader will perhaps deem unnecessary, finding that the present list is long enough.

Having discovered the amount and importance of the several defects in the principle of construction of ancient stills, and the various evils attendant on, and the liabilities resulting from their use, it next becomes necessary closely to investigate the several objects which it is desirable to accomplish in the process of the distillation of spirit, and the various causes of the inadequate capabilities of those stills to accomplish them: and in reply to the enquiries relative to those objects, we are furnished with the following desiderata; the separation of alcohol of the greatest attainable strength and purity in the least possible number of distillations, at the least possible cost, in the least possible time, and with the least possible risk.

If we estimate the produce of 100 gallons of distiller's wash at 16 gallons of proof spirit, and the highest attainable commercial strength of alcohol at 60 per cent. over proof, and if it were possible to obtain alcohol at such a strength at one distillation, the produce of alcohol would be in the ratio of 10 gallons from every 100 gallons of wash; and could a still be procured capable of effecting such an object, and a perfect system to work it, the desiderata of the highest attainable strength and purity would at once be accomplished; but we are not aware that any still has yet been invented, or system of operation adopted, which is capable of effecting it, and it will be found that both the crane neck still and the alembic are very far from being adequate to the accomplishment of such a purpose.

Assuming that the average strength of the whole of the spirit obtainable from 100 gallons of wash containing 16 gallons of proof spirit, by either of the above stills is 50 per cent. under proof, the quantity brought over into the receiver will be found to be 32 gallons from every 100 gallons of wash, instead of 10 gallons at 60 per cent. over proof, leaving 68 gallons of wash in the still instead of 90 gallons; and it is this serious inefficiency of such stills, which renders the use of the agitator absolutely necessary, as by the abstraction of so large a proportion of the diluent fluid, the density of the remaining wash is so much increased, as to cause the liability of its adhesion to the still and consequent burning, unless kept in a state of continual agitation; and we presume that it must be evident to the practical distiller, that if he could abstract the whole of his spirit, in the ratio of 10 gallons from every 100 gallons of wash instead of 32, that he would then be able to dispense with the use of the agitator.

To cause 32 gallons of spirit to pass over into the receiver instead of 10 gallons, it must be obvious that the same cause which admits of the unnecessary transition (if avoidable) of 22 gallons, will also allow the transition of a portion of oleaginous, acetic and mephitic vapours in admixture with the aqueous; and the whole being together condensed are conveyed to the receiver, as a very impure compound. It must be also evident that the quantity of fuel and condensing water, and the period of time which is occupied for the production of 32 gallons of spirit, must much exceed that which would be necessary for the production of 10 gallons in one distillation, and if we assume that three distillations are necessary to produce alcohol at 60 per cent. over proof with such stills from wash, it needs no calculation to prove the very large amount of saving that would be made, by effecting such an object by one operation.

It will thus appear evident that the strength and purity of spirit, and the economy of its obtainment, are intimately connected, and that by an endeavour to accomplish the first, the two additional desiderata must also be obtained.

In relation to the risk of obtainment of spirit of high strength and purity, every necessary endeavour to obtain strength and purity by the ancient stills, and every improvement made in the construction of modern stills with a view to accomplish such a purpose, are both strongly and decidedly in favor of a diminished risk; for as the risk consists in the insecurity of the connection of the head of the crane neck still and the alembic with the body, although such insecurity is the necessary submission to the lesser evil in order to avoid the occurrence of the greater, so the prevention to the liability of the greater evil by an improved mode of construction, renders unnecessary the continuance of the lesser evil; but to judge fairly of the necessity of an endeavour to obviate the risk, and the mode by which it may be accomplished, it is necessary to take a review of the process of distillation of wash in the crane neck still.

Assuming that the wash contains alcohol in the ratio of 10 gallons at 60 per cent. over proof in every 100 gallons, such alcohol is intimately blended with, and equally diffused over the whole mass, and the still is charged therewith, and the head put loosely on, in order to avoid the risk of bursting, by risking the lesser evil of blowing, and luting is well applied to such connexion, to prevent the escape and loss of spirit by leakage provided blowing does not occur. It then becomes the stillman's care so to attend to and regulate his fire, in order to prevent the liability of generating vapour of sufficient power as to either force out his luting or a portion of it, to raise the head from its seat, or cause the bursting of the still; and by a strict endeavour to avoid either of such liabilities, he will obtain his spirit but slowly, but the want of speed will be more than compensated by the obtainment of all the spirit without loss and of greater strength.

But the distiller is hedged round with excise restrictions, and among many others, it is required that he should work off his still within a certain number of hours after charge; and although the time allowed may be sufficiently ample to admit of its being properly accomplished within the allotted period, yet various casualties and circumstances may delay the commencement or retard the progress of the process, and the stillman may find himself compelled to urge on his still to the height of its capabilities, with a view to run it off in time, and if not so compelled, he may be induced by a desire to get his work accomplished early, or he may be negligent, careless, unskilful, or needing judgment, and thereby cause all the liabilities of a waste of spirit by the oozing or issuing of vapour to a small or large amount, and its probable deflagration including the containing premises. In proportion to the diminished strength of the wash with which the still is charged, or the nearer the termination of the process of distillation, the greater is the liability of bursting to occur; for as the alcohol is diffused throughout every portion of the wash, a greater amount of heat is requisite to bring off the latter portions of spirit, which are more remotely situated from the upper surface of the wash than the first and succeeding portions. To comprehend this subject more clearly and fully, it is necessary closely to investigate the mode by which heat is imparted to the wash, to convert the spirit which it contains into vapour, and the effect of the impartation. And the more clearly to effect the purpose of illustration, we will first premise, that a distiller's wash is compounded of alcohol, water, essential and gross oils, acetic acid, and vegetable extract, among the whole of which, the alcohol which is required to be separated is intimately mixed. We will next premise that the temperature of evaporation of each of these substances differs, that of alcohol being the lowest; that the heat from the burning fuel is imparted to the bottom and sides of the still below the water line; that such heat passes through the metal to the wash and immediately rises to the upper surface, and there accumulates until the temperature of such surface attains to about 176 degrees, when alcoholic vapour begins to rise, ascends to the helm, and passes over by the worm into the receiver. If the whole of the alcohol was situated at the upper surface of the wash, it would be sufficient to continue the impartation of heat with that precision and regularity, as would keep the upper surface at that temperature and no higher, and the whole of the alcohol would soon be separated at the greatest strength and purity from the wash. But as such is not the case, and the temperature of the lowest surface of the wash must attain to about 176 degrees before the alcohol there situated can ascend to the upper surface and there be converted into vapour, it necessarily follows that in obedience to the law of recession to which heat is subject, that the upper surface must attain to about 212 degrees, before the lower will have reached about 176 degrees; and it therefore follows as a case of necessary consequence, that aqueous vapour is generated long before the whole of the alcohol can be separated; and to obtain the whole of the latter, a very considerable portion of the former must be carried over into the receiver, and with it the several vapours that constitute the impurities in admixture with the spirit.

Such being the defect of the crane neck still and the alembic, and it being impossible to separate the whole of the alcohol from wash without generating a very large amount of aqueous and other vapours, it became necessary to devise some means to separate the alcoholic vapour from the rest, subsequent to their conjunctive creation, to carry the alcoholic vapour over the helm, and to precipitate the aqueous and other vapours by condensation into the body of the still; and happily for the effecting of such purpose, the great difference in the temperature of evaporation of alcohol and the other components of the wash, presents the requisite facility.

The principle of improvement then upon those stills, should consist in thus separating and carrying the alcoholic vapour over the helm, and precipitating all other vapours by condensation to the body of the still; and it is upon such principle that the majority, if not the whole, of the various modified improvements are founded; and as we have satisfactorily proved we trust, that to obtain alcohol of the greatest strength, is also to obtain it of the greatest purity, in the least number of distillations, at the least cost, in the least time, and with the least risk, it must be evident that such still as will produce the strongest alcohol from wash, will most probably furnish all the other desiderata.

Among the several inventors of stills upon such principle we claim a place; and although we cannot boast of having furnished one that is capable of producing 10 gallons of alcohol at 60 per cent. over proof at one distillation, from wash containing 16 gallons at proof in 100 gallons of wash, yet we have succeeded to a near approximation—one that will produce 12⅓ gallons at 30 per cent. over proof. And as by the rule of proportion of strength we calculate the purity of spirit, and the accomplishment of the other desiderata, so it will be evident to the reader, that whatever may be its merits, it falls somewhat short of the standard of perfection, which we have assigned to the productive capabilities of the still.

The still of our invention being but a small experimental model, and as one upon a large scale has not been manufactured, we can only judge of the performance of a thousand gallon still by calculation, founded on the data furnished by the model; and whether the results of the one would be proportionate to the other must be a case of conjecture, but as an experimentalist we should imagine that, all the advantages in production would lie on the side of the large scale. But it shall be our business to furnish the process by calculation, as relates to the several interesting considerations which we are able to supply, and leave to our readers the opinion as to the probability of their being realized in practical magnitude; and the following we submit as the ascertained details, observing that the species of fuel consumed in effecting the experimental distillations, will furnish no calculative evidence of the amount of fuel of the usual description which would be consumed in the process.

Quantity of wash with which the still is charged, 1000 gallons; quantity of proof spirit contained in such wash, 160 gallons; quantity of alcohol at 60 per cent over proof, 100 gallons; computed strength of wash, 84 per cent under proof; time occupied in effecting the process of distillation, from the time of lighting the fire, until the whole of the faints are drawn off (calculating upon half an hour being requisite to raise the wash to an evaporating temperature, and the production of the first portion of spirit,) one hour and a half; quantity of spirit brought over into the spirit receiver, 107 gallons; average strength of spirit in the spirit receiver, 45 per cent. over proof; quantity of faints brought over into the faints receiver, 16 gallons; strength of faints brought over into the receiver, 70 per cent. under proof.

Total quantity of spirits and faints, and the average strength of spirits and faints, 123 gallons at 30 per cent. over proof.

Quantity of water used in the condensation of spirit and faints by our refrigerator, 1500 gallons.

Temperature of water from the reservoir used for the purpose of condensation, 65 degrees.

Average temperature of water issuing from the refrigerator used for the condensation of the spirit and faints, and the precipitation of the aqueous and other vapours into the body of the still, 178 degrees.

The cost of such a still and the accompanying refrigerator, we believe would not exceed the cost of a crane neck still or an alembic, and its accompanying worm tub and worm.

As the quantity of spirit separated from the wash is so small compared with the usual quantity brought over by the crane neck still or alembic, it is presumed that the agitator cannot be needed in a large still, and it is known that it is not in the model.

The head is permanently attached to the body of the still, and luting is therefore not necessary, and consequently no alcoholic vapour can be lost by blowing or leakage.

A safety valve being supplied to the body of the still, opening into an internal chamber in the head, the liability of bursting is entirely prevented.

As no condensation within the body or head of the still can occur to the extent of creating a vacuum, it is impossible that collapsion can occur.

The head of the still contains two water baths, two condensing chambers, and one alcoholic vapour chamber.

Heat being imparted continuously to the wash in the body of the still, and the upper surface having attained to a temperature of about 176 degrees, the alcohol at such surface is converted into vapour, and if the temperature of the first water bath exceeds 176 degrees, such vapour will pass by such bath and arrive at the condensing chamber where it is converted into liquid alcohol, and flowing into the alcoholic vapour chamber, is therein re-converted into vapour by the radiation of heat from the metallic medium which divides such chamber from the body of the still, and ascending to the second water bath, it passes by that also, if its temperature exceeds 176 degrees, and arrives at the second condensing chamber, wherein it is again converted into liquid alcohol, and from thence it passes through the refrigerator into the receiver. But if the first water bath is at a lower temperature than 176 degrees, the alcoholic vapour is condensed and precipitated into the body of the still, wherein it is again re-converted into vapour, and such precipitation and re-conversion into vapour continues until the water bath is raised to a temperature above 176 degrees, by the impartation of heat from the vapour to the water in the bath through the metallic medium which divides the two; and the same process occurs as relates to the second water bath.

If the impartation of heat to the wash in the still is to an amount sufficient to raise the temperature of the upper surface to about 212 degrees, then aqueous and other vapours will rise with the alcoholic, and being presented to the first water bath, they will be condensed, and precipitated into the body of the still provided the temperature of such bath is not equal to the temperature of the aqueous and other vapours, and the alcoholic vapour will pass by uncondensed, and thus be separated from the aqueous and other vapours, unless those vapours should be presented to the water bath too rapidly and in too great a quantity for their condensation, when such as are not condensed will pass on with the alcoholic vapour to the first condensing chamber, from which they will flow in a liquid state into the alcoholic vapour chamber, and therein be again converted into vapour, and rise to the second water bath, and which the aqueous and other vapours will also pass if presented too rapidly or abundantly or the water in such bath is of an equal temperature to them.

Herein then will be perceived the utility of both the first and second water baths, the first to prevent the passage of all the aqueous and other vapours which it is able to condense, and the second to condense such has have passed the first as far as it is capable; and it is the stillman's business so to regulate the flow of water through such baths, as that their temperature shall but little exceed 176 degrees, and the closer he keeps them to such point, the stronger and purer will be the alcohol, and the smaller the amount which will pass over into the receiver.

It must be plain and obvious that this still and many others upon the same principle, are perfect as relates to the abstract principle, that of separating the aqueous and impure vapours from the alcoholic, by the condensation and precipitation of the former by a medium of suitable temperature, and which will admit of the passage of the alcoholic vapour uncondensed, as a necessary consequence of its lower evaporating temperature, and that the very great difference in the evaporating temperature of the alcoholic and other vapours very much facilitates the operation; but it will also at the same time be perceived, that the imperfection of all such stills consists in the inability of the water baths to abstract as much heat as is necessary from those vapours and with sufficient rapidity, as will prevent the passage of a portion, unless the quantity and the rapidity with which those vapours are presented to their surfaces, is within the limits of their heat abstracting capabilities; and it will be further perceived that the greater the amount of the radiating surface which such baths present, the lower the temperature at which they are kept above the evaporating temperature of alcohol, and the smaller the amount of vapour, and the less the impulsive rapidity with which it is presented to such surfaces, the more perfect will be the operation of the still.

All the advantages which this and other improved stills furnish for the distillation of spirit from wash, apply to the rectification and flavoring of spirit by distillation; and we claim for our still the same merit which some others possess, the convenient supply of a well adapted receptacle for the flavoring ingredients, which the alcoholic vapour chamber furnishes, and in which the ingredients being placed, alcohol of great strength and purity flows in upon them from the first condensing chamber; and in such liquid alcohol they remain continually steeped during the process, imparting to it their flavor by infusion, at a lower temperature than would occur if they were placed in the body of the still; and the alcohol thus impregnated with the essence of their flavor, without the admixture of their grosser oils, is conveyed to the receiver, and found to be a purer, and consequently a more wholesome and agreeable compound.

By experimental essay we have found, that our still is able to furnish at one distillation only, from wash of any strength, a much stronger and purer spirit than the usual spirit of commerce which is offered in the market.

By submitting such spirit to the action of our peculiar rectifying or purifying ingredients in a cold state, previous to the admission of such spirit into the rectifying still, and subsequent to the separation of such spirit from a portion of such ingredients without waste, we are enabled to charge such still without the presence of such ingredients, and to carry over a spirit of superior purity by the first water bath, and through the condensing chamber to the flavoring ingredients in a liquid state, and deriving from them their essential aromatic flavor, carry over the compound into the spirit receiver, a pure and well flavored spirit, performing the operation of rectification and flavoring in one distillation; and thus perform in two distillations, that work which is usually performed in four or five by the crane neck still or alembic, and productive of as good an effect; but at the same time we are in justice bound to say, that a third distillation will furnish a better produce, and we believe, superior to any that can be effected by those stills.

The flow of water through the refrigerator, is at a speed in the ratio of the temperature at which the spirit flows into the receiver, as regulated by a self-acting apparatus; therefore while the supply of water is continuous, and to the amount needed from the reservoir, and its temperature does not exceed 65 degrees, no alcoholic vapour can pass into the receiver, let the intensity of the fire be ever so great, as the regulating apparatus admits a supply of water to the refrigerator, proportionate in amount to the temperature at which the spirit comes into the receiver; and as the water admitted into the refrigerator passes from thence into each, and from each of the water baths within the head of the still, so the greater the quantity of water which passes through them, the greater is the reduction of their temperature, and being reduced below the temperature of evaporation of alcohol, no vapour can possibly pass by them, but is condensed and precipitated as fast as generated, let the heat imparted be ever so great; and thus by this valuable system of mechanism, the evil is rendered capable of furnishing and applying its own proper remedy.

The principle of construction of the refrigerator comprises the division of the alcoholic vapour into minute portions, and the presentation of them to an extensive radiating metallic surface in their passage to the receiver; and the division of the condensing water into minute portions in its continuous passage to the two water baths, abstracting heat from the vapour through the metallic medium, and gradually increasing in temperature in its progress.

The construction of both the still and the refrigerator, are we believe consistent with the excise regulations and restrictions, and we conceive that together they exceed in simplicity, effectiveness, and smallness of cost, any modern distillatory apparatus that has yet been offered to the public.

SYNTHESIS, ***the uniting of substances or atoms to form bodies or substances.***

Synthesis.

The term synthesis is used to designate the labours of those who form bodies or create substances, as induced by a foreknowledge of the effects which will or probably may be produced by the performance of certain processes and operations, founded upon a previous observation of the productive effect, and an intimate knowledge of the properties, tendencies, and capabilities of the substances or atoms which are the subjects of their manipulations.

Synthetical knowledge is of the highest order attainable to by man, but its measure of perfection is exclusively an attribute of deity.

To create atoms, to divide them into classes, to apportion their dimensions, to devise their form, to impart their properties, to imbue them with their sympathies, their affections and their tendencies, to furnish them with power, to prescribe their laws of action, and bid them with unerring order, promptitude and precision, unite and disunite, and together form a countless myriad host of animated beings and inanimate things, subject to everlasting change, to decomposition and to re-composition, without the destruction of a single atom, required the omnipotence, the omniscience, the omnipresence and the infinite wisdom of the great creator of the boundless universe.

The small amount of synthetical knowledge, acquired by human beings of the highest intellectual capacities, as the result of a long life spent in the laborious acquirement, appears as but the permissive glance of the stupendous works of creation, or as the indistinct and telescopic view of the boundless power and inconceiveable wisdom of the creator; and the attainable amount is but as the drop compared to the ocean's bulk.

Synthetical knowledge leads to the formation of a body or substance, and analytical, to the decomposition or destruction of either.

The utility of synthetical knowledge is to enable its possessor to form or create a definite or well known body or substance, by the combination of definite substances or classes of atoms, and definite proportions of them.

The utility of analytical knowledge is to enable its possessor to decompose pre-existing bodies or substances; to divide and separate their several substances or classes of atoms; and to ascertain their names, amounts, and relative proportions, with an ultimate view to the obtainment of synthetical knowledge.

The obtainment of analytical knowledge by man is primary, and synthetical, secondary; but the purport is in the reverse order of arrangement.

The formation or creation of malt, beer, spirit, &c. are the result of synthetical operations, but a knowledge of the mode of performing them is derived from analytical knowledge, which has furnished all the requisite information, and established a systematic course of procedure to enable the accomplishment.

It is true that the mere practitioner may successfully perform all the necessary purposes, without that (which, for illustration sake, may be termed) inherent analytical or synthetical knowledge; but yet his imitative knowledge is based upon the acquired substantial analytical or synthetical knowledge of some original discoverer; and although the imitation is to the original but as the ray of light to the source from which it emanates, yet is its utility proportionate to its fructifying influence.

If therefore the obtainment of such knowledge by the original discoverers and improvers of such arts, has led to the establishment of those systems of practical manufacture, which have conferred benefit on millions, the acquirement of an elementary knowledge of such systems, must surely be far more advantageous than the superficial knowledge, which too many of the present day content themselves with the possession of.

We are decidedly of opinion that every manufacturer should, previous to his commencing the performance of the several processes of the factory, receive elementary tuition in every branch of science, connected either directly or indirectly with every subject relating to the materials of his manufacture, and with the mode and manner of its accomplishment; and we should strongly recommend the obtainment of an intimate knowledge of the various substances which compose the whole of the materials used in every process, by personal experimental analysis, and the recorded information to be derived from the experimental essays of others; and we conceive that the establishment of (what we should term) an elaboratory academy, in every populous town, for the instruction of youths intended to be brought up as operative manufacturers, would prove highly serviceable to the welfare of the arts, manufactures, and commerce of the kingdom.

THERMOMETER, *an instrument for measuring heat.*

The inestimable benefit which the inventor of the thermometer has conferred upon science and manufactures, and every individual connected with their progress and improvement, is such as renders him entitled to a monumental memorial of gratitude, reared by the conjunctive efforts of every participant; and of such indispensable utility has it become to an innumerable class, as to excite the feelings of wonder and surprise, how our ancestors could ever do without it.

Both the principle of action and construction of the thermometer, should be well understood by every manufacturer who may have occasion to use it; not only on account of its great utility as an instrument for the admeasurement of the amount of heat imparted and received, but as furnishing an illustrative evidence of the transition of heat from one body or substance to another, and the probable mode by which it is effected, leading the mind to investigate the laws which govern the transmission, and all the facts and circumstances connected therewith.

The thermometer usually consists of a hollow cylindrical glass tube attached to a globular bulb partly filled with mercury, the residue of the space within being a vacuum, and the end of the tube is hermetically sealed, which is affixed to a graduated plate, furnishing a scale from 20 to 212 degrees of heat for general commercial use, and a scale of more extensive range for scientific and such manufacturing processes wherein it is necessary to ascertain the absence or presence of heat to a much greater amount.

In the construction of a thermometer, the first operation is to insert into the glass tube and bulb, as much mercury as is sufficient to admit of its expansion and contraction by the impartation and abstraction of heat, to the required limits within the tube. The next operation is to expel the whole of the air from such tube in order to create a vacuum, and then to hermetically seal or close up the open end, and this process is usually effected by the impartation of as much heat to the mercury as will enable it to expand and occupy the entire space within the tube, and having facilitated the abstraction of the whole of the air by the frequent inversion and agitation of the tube, the open end is hermetically sealed or closed, by its partial fusion, or the rendering of it soft or semi-fluid by the impartation of a powerful heat by means of a blow pipe, and then closing the orifice by pressure. This being done, the bulb and tube are next attached to a suitable and unengraved plate, and the whole immersed in some suitable medium, that will indubitably furnish a correct and definite known standard of low temperature, and a line is drawn on the plate parallel with the upper surface of the mercury within the tube, and such line is then intended to denote the temperature of any substance in which the thermometer may be immersed, which may cause the level of the mercury within the tube to range to that point. The next step is to immerse the tube and plate in boiling water or some other medium, whose temperature of ebullition is well known, and another line is drawn on the plate parallel with the mercury in the tube, which mercury is expanded considerably by the impartation of heat, and this second line denotes the boiling temperature of such fluid, and the corresponding temperature of any other substance in which it may be subsequently immersed. The two extreme temperatures which it is intended that such thermometer should denote being ascertained, the distance between the two engraved lines is then carefully divided into as many equal parts as there are degrees of heat between the two standard points, and as many corresponding lines are drawn upon the plate, each line expressing a degree of heat. A subdivision then of each of those spaces into five or ten equal parts is made, and shorter lines are drawn to express either two-tenths or a tenth of a degree of heat, and thus the instrument is rendered competent to express the temperature of any substance in which it is immersed, to the tenth of a degree of heat.

In accurately noticing the effects resulting from the immersion of a thermometer in a fluid of a greater temperature than the materials composing such instrument, we perceive that a diminution of the heat and bulk of the materials of the fluid, and an increase in the heat and bulk of the materials of the thermometer occurs, and that the mercury in the tube expands and rises higher; and from such occurrence we deduce, that a transition of heat from the fluid to the materials composing the thermometer has taken place; and judging from the expansion or increase in the bulk of the mercury, we infer that heat has permeated the glass tube to cause such an effect; and from the appreciable expansion of the plate to which such tube is affixed, we conclude that a portion of heat which the fluid has lost, and the loss of which has diminished its bulk, has passed into such plate, and increased its temperature and bulk; and from the observance of these several apparent facts, we deduce the following inferences: that the plate and glass bulb and tube are compounded of material ponderable and imponderable atoms, the ponderable being united by attraction of aggregation and held together by attraction of cohesion; that the mercury is compounded of ponderable atoms, the ponderable atoms being united by attraction of aggregation only; that the form of the atoms composing such plate, bulb and tube, and mercury, are spherical, and that consequently in such state of union they present interstices or areas, which may contain atoms of much less dimensions than the ponderable atoms, the union of which furnish those areas. That the imponderable atoms denominated heat are material, spherical, and much smaller than the ponderable atoms. That such ponderable atoms being spherical, are susceptible of motion without separation, and that being subjected to such motion without separation, they may occupy a greater space than they previously did, and therefore any solid body is susceptible of expansion and contraction to a limited extent, without a disunion of their ponderable atoms, which if occurring, would deprive it of its characteristic as a solid body—the cohesion of its ponderable atoms. That the imponderable atoms of heat are subject to the law of equal diffusion, and that the power conferred by such law is superior to such as is conferred by the law of attraction of aggregation or cohesion. That two spherical ponderable atoms under the powerful influence of attraction of cohesion and united at minute points, may be separated the one from the other, by the impulsive force of an atom of heat passing between them in obedience to the law of equal diffusion, and return to a state of cohesive union, in obedience to the law of attraction of aggregation, such atoms never having been removed beyond the sphere of such attraction. That the number of atoms of heat which pass into the interstice or area presented by the union of three or more spherical ponderable atoms, being more than sufficient to fill it, may cause the motion and the occupation of a greater space by such ponderable atoms without disuniting them, and thereby cause the effect termed expansion. That the ponderable atoms composing a solid, occupy the smallest possible space in virtue of the law of attraction of aggregation, provided the interstice or area which would be presented by the closest union of three ponderable atoms, is not preoccupied by more of the imponderable atoms than is sufficient to fill it; and if three ponderable atoms occupying the least possible space are displaced from their natural position by the impulsive power of intervening atoms of heat and occupy more space, (termed expansion) than they previously did, they will return to their original position (termed contraction) upon the abstraction of such heat, in virtue of the unimpeded action of attraction of aggregation. That ponderable atoms united by attraction of aggregation only, and not by attraction of cohesion, are separated from each other by atoms of heat in obedience to the law of equal diffusion, with much greater facility than are the ponderable atoms united by the power of attraction of cohesion. That the difference between the power or force of attraction of aggregation and attraction of cohesion, is due to the difference in the intensity of the power or force of affinity subsisting between the several classes of ponderable atoms of which the several bodies may be composed, whose ponderable atoms are held united by the two distinct laws of attraction of aggregation and attraction of cohesion, or rather the law of aggregation, and its supplementary law of attraction of cohesion.

Agreeable then to this theorem, (to say nothing of the plate) we conceive that the ponderable atoms of which the glass bulb and tube are composed, are united by attraction of cohesion, and those of which the mercury is composed, are held in union by attraction of aggregation; that being immersed in a fluid or any other substance, containing more heat in a free and active state than is possessed by the glass and the mercury, as much heat will pass by transition from such fluid or other substance to the glass and mercury, as will render the amount of free and active heat possessed by each quite equal; that the heat which passes through the glass to the mercury, displaces the ponderable atoms of which the glass is composed, between which it passes during its passage, but that as soon as such heat has passed, those ponderable atoms return to their former position, in virtue of the law of attraction of aggregation and cohesion, and this passage is effected by the heat, without destroying the solidity of the glass, which solidity depends upon the permanent cohesion of its ponderable atoms. The heat having passed through the glass and finding no unoccupied interstice or area between the ponderable atoms of which the mercury is composed, (they being previously occupied with constituent or latent heat) necessarily forms an addition to the total bulk without any room for occupation, unless it makes a provision by force and the removal of other atoms against which it impinges upon its entrance; and as such an effect is produced by the entrance of atoms of heat from the fluid or other substance through the glass bulb and tube among the atoms composing the mercury, an expansion of such mercury occurs in the direction of the unoccupied space—the vacuum, with a celerity and to an extent proportionate to the speed and amount of the atoms of heat which enter through the bulb and tube. As the amount of constituent and latent heat of glass may not be sufficient to fill the interstices or areas furnished by the union of the ponderable atoms of which it is composed, a considerable amount of free and active heat may be required to fill up those interstices or areas before any motion of the ponderable atoms can occur, and consequently any expansion of the glass can be appreciated; and we attribute the difference in the receptive capacities for heat of various bodies to the difference in amount of their constituent latent heat.

Before we close this article, we cannot resist the temptation to offer a solution of that hitherto (we believe) unsolved problem—the cause of the expansion of water in freezing, and of the expansion of ice in thawing; the first operation appearing paradoxical, as relates to the usual effect resulting from the abstraction of heat from bodies, causing expansion instead of contraction; and the second operation appearing equally paradoxical, as opposed to the effects resulting from the first; both the abstraction and impartation of heat to the same atomic materials, causing a similar instead of an opposite effect.

In noticing accurately the effects resulting from the congelation of water, we find that an abstraction of heat therefrom, to an extent sufficient to reduce its thermometric temperature to 32 degrees, must first be accomplished, and when performed we still find that the water is fluid, which we attribute to the presence of heat intermixed with the ponderable atoms of which the water is composed, to a greater amount than will admit of their touching each other at minute points, and consequently preventing their cohesion and the formation of a solid body, termed ice. A further abstraction of heat is then necessary to effect solidity, and we will suppose that the surrounding atmosphere is able to effect it agreeable to the law of equal diffusion to which heat is subject, the atmosphere being of a lower temperature than 32 degrees; and if we attentively consider the result, we must conclude that the ponderable atoms are acted upon by two forces at the same time—the impulsive force of the atoms of heat in their transition from the interstices or areas to the atmosphere in obedience to the law of equal diffusion, and the impulsive inherent force of the ponderable atoms endeavouring to unite in obedience to the law of attraction of aggregation, and to occupy the least possible space; and it is easier to conceive than describe, that the result of the operation of these opposing yet unequal forces, will cause a change in the geometrical position of the ponderable atoms, causing them to occupy more space than they did previous to cohesion, and yet such change of position not prevent their cohesive union.

It may also be conjecturally conceived, that in the solidification of water, the ponderable atoms may be placed in such a geometrical and cohesive position, as not to be able to resume their natural position—the occupation of the least possible space, when the transition of heat to the atmosphere ceases; and thus the solid (ice) is left permanently expanded, until it is reconverted into a fluid; but before such conversion can be effected, a large amount of heat must re-enter into the vacated interstices or areas, and again must the ponderable atoms be separated to admit of the transition of such heat for the purpose, and thus a second expansion of the solid is effected during the process of its conversion into a fluid.

VACUUM, *space unoccupied by matter.*

It is proverbially said that "nature abhors a vacuum;" and it is evident that although she admits of the capability, and has conferred the power of effecting it, and in a variety of cases avails herself of the principle, yet in the system of natural economy, it is but as an exception to a rule.

The several modes by which a vacuum is usually created for mechanical purposes, with which we are the most familiar, and which confer the greatest social benefits, are by means of the several description of pumps, by which water is raised from great depths in the interior of the earth to the surface, effected by the abstraction of air from the pump barrel and suction pipe, the pressure of the atmosphere upon the surface of the water in the well causing it to occupy such vacuum as soon as created. Also by the steam engine, in the cylinder of which a vacuum is created by the condensation of the steam admitted, causing the atmospheric pressure upon the piston, to furnish a motive power to the connecting machinery; and also by the air pump connected with the cylinder of such engine, to abstract the air supplied to it by the steam and the injection condensing water. In the construction of the thermometer, creating a vacuum in the glass tube above the mercury to admit of its unimpeded expansion; and in the syphon by an abstraction of the air therefrom, in order to remove it as an impediment to the entrance of the fluid contained in the vessel in which it is inserted, impelled by the pressure of the atmosphere upon its surface.

In mechanical and chemical operations we find that the creation of a vacuum is highly calculated to facilitate the process of evaporation, as by the removal of atmospheric pressure from the surface of the fluid, its evaporating temperature is much reduced below the standard amount when subject to such pressure, and the space above being unoccupied by a restrictive medium, enables the transition of the created vapour to the receiver with much greater rapidity, and its creation with a much less amount of heat; and this effect may be well appreciated if we refer to the still, and consider that the space above the fluid is filled with air which presses upon the surface of such fluid, in the ratio of about 15 pounds to every square inch of the area of such surface, and that before vapour can be generated and evolate from its surface, the superincumbent air must first be removed from it, which is equal to the raising a weight in the ratio of 15 pounds per every square inch of such surface; and on the supposition that the area of such surface is 1000 square inches, then is the weight to be raised 15000 pounds before vapour can be generated, and the impulsive power of accumulated heat at such surface, must be the force employed to raise such weight before an evolation can occur, and by the creation of a vacuum, a superincumbent weight to that amount is in such case removed from the surface of the fluid, and consequently a less amount of the impulsive heat is required.

In the evaporation of fluids in open vessels, the surface is covered and in contact with atmospheric air continually during the whole process, and that stratum of air which immediately covers such surface, must become of the same temperature as the fluid before the generation of vapour can be effected; and as the impartation of heat to such air diminishes its specific gravity, so therefore it ascends and leaves the surface of the fluid, and its place is occupied by air of a lower temperature, and thus a much greater amount of heat is abstracted from the fluid, a greater diminution of the impulsive power is effected, and a less amount of steam is generated; and thus it will appear evident that the presence and frequent change of atmospheric air presents two impediments to evaporation—a great superincumbent weight, and abstractive medium of heat, which should be devoted to the generation of vapour. And by the evaporation of fluids in close vessels it will be found, that the space above the fluid being filled with air, the same weight must be raised before evaporation can commence; and although the vapour which is generated will expel the whole of the air from the vessel, yet will the atmosphere press upon the orifice from which such vapour issues, with a force equal to its natural pressure upon the whole surface of the fluid in the boiler, inasmuch as the vapour generated, issues from such orifice with a velocity, in the ratio of the area of such orifice multiplied by the amount of steam generated.

By the creation of a vacuum in an evaporating vessel, and a connected receiver of the products of evaporation, (insomuch as relates to the space therein which is occupied by air) the fluid which it contains may be evaporated by a much less amount of heat, provided the vapour is condensed in its passage to the receiver, than would be sufficient in case the atmosphere pressed immediately upon the surface of such fluid, or opposed the egress of the created vapour from an orifice; and it should be remembered, that by the removal of the pressure of the atmosphere from the fluid within, the entire weight is thrown upon the external surface of the vessel, and consequently its form of structure should be the best adapted to bear such pressure, and the strength of the material of which it is composed should be more than adequate to endure it.

As many fluid and solid substances exposed to atmospheric air at a high temperature, are liable to experience chemical injury by the combination of gases held in simple mixture with such atmospheric air, or by the combination of oxygen therewith, resulting from the decomposition of such atmosphere, it becomes a question, whether both the process of evaporation and fusion, if more frequently practised in vacuo, would not prove a preventive to those chemical injuries which are often experienced.

VAPID, *dead, flat, spiritless.*

The presence of carbonic acid gas in all fermented fluids at the period of consumption, is indisputably requisite to render them grateful to the palate, and it is necessary that the first process of fermentation should be so far conducted, as to leave a sufficient amount of the extract (from whatever material) undecomposed, in order that a subsequent formation of carbonic acid gas may be effected, by what is termed the second or ulterior fermentations to which such fluid may be subjected, and to which it is rendered liable by the retention of such undecomposed material.

The second or any subsequent fermentation, is the result of the impartation of oxygen from the atmosphere to the fluid, its combination with the carbon of such fluid, the production of carbonic acid as the effect of such union, and its conversion into carbonic acid gas, by the liberation of latent heat, consequent upon the decomposition of the vegetable extract which the fluid contains, and the accretion of such heat to the carbonic acid as a constituent requisite.

Should the first process of fermentation be conducted so rapidly, as to cause the evolation of all the carbonic acid gas which has been generated, the fluid will necessarily taste vapid; or should the first process be conducted to such an extent as to leave but little extract undecomposed, and consequently not sufficient to create carbonic acid gas to the required extent during its consumption, then will it also drink vapid. If also the atmospheric temperature is such as to abstract the whole of the heat which is liberated from a state of latency to a state of freedom, by the operation of the law of equal diffusion to which heat is subject, and thereby prevent the formation of carbonic acid gas, then will the fluid be deemed vapid.

An exposure of a fermented fluid to the atmosphere, for a period sufficient to cause the evolation of all the carbonic acid gas which has been generated, will cause the fluid to be vapid.

Water in its natural state contains a large amount of carbonic acid gas, which renders it peculiarly grateful to the animal taste, but of which it is deprived by the process of boiling, and such deprivation causes it to taste vapid; and as the animal system requires a large supply of carbonic acid, its presence, or the materials for its composition in the liquid and solid food consumed, is indispensably requisite to sustain and support the operations of the animal functions.

VINEGAR, *a fluid which has been subjected to an acetous fermentation.*

All vegetable extracts which furnish saccharum or the materials for its composition, are, in a state of solution by water, liable to an acetous fermentation and to the production of vinegar.

The solution of vegetable substances by water, and the vinous fermentation of the resulting product, should precede the acetous fermentation, in order to the formation of strong, well conditioned, sound keeping, and pleasant tasted vinegar.

The fruit, grain, or vegetables which are the best calculated for the production of vinegar, are those which either contain the most saccharum at the period of their being subjected to the process of solution, or which possess the greatest amount of those materials which are necessary to the formation of saccharum, by a subsequent process of fermentation; and hence fruit, grain, or vegetables of full maturity, and which have experienced a favorable growth, and process of ripening, are the best adapted for the production of good vinegar.

It is necessary that the vinous process of fermentation should not only precede the acetous, but that it should also be conducted to the full extent of capability, without having recourse to violent measures to effect it, so as to incur the liability of causing the commencement of an acetous fermentation previous to the termination of the vinous.

To conduct the process of fermentation through the several stages in the consecutive order of arrangement which nature has established, the vinous process should first be conducted to an extent sufficient to cause the decomposition of the fermentable extract as far as it is capable to effect it, and that the result of such process should be the production and evolation of a large amount of carbonic acid gas, the coagulation and ejection of much gluten, the creation of a great quantity of spirit, and the diminution of the density and specific gravity of the fluid. Upon the termination of the vinous fermentation the acetous should commence, and the resulting effects should be, the gradual conversion of the spirit into acetic acid, and the increase of the density and specific gravity of the fluid. And upon the cessation of the acetous fermentation, the putrefactive should follow, and the resulting consequences should be the gradual abstraction of the whole of the acid, the creation of mephitic gas, and the putrefactive decomposition of the fluid.

In the manufacture of vinegar, the endeavour should be to proceed systematically through the first and second process, to stop short of the third, and prevent the liability of its occurrence; but as the fluid submitted to the process of vinous fermentation for the manufacture of vinegar is unprotected by the presence of hop extract, so is it liable to experience the commencement of the acetous process of fermentation in conjunction with the vinous, and therefore every necessary precaution should be adopted to prevent such an occurrence.

To the uninformed it may appear to be a case of but little consequence, if the fluid submitted to vinous fermentation should experience an acetous fermentation in conjunction, and they may imagine it to be an advantage; but it will be found in practice, that fermentable fluids thus treated, will not ultimately furnish so large an amount of acetic acid, as those which pass through the vinous process, without a conjunctive commencement of the acetous process of fermentation. It is usual therefore for the vinegar manufacturer to brew and to conduct the process of vinous fermentation in the autumn and winter, in order to avoid the liability of the acetification of the wort in the process, and to conduct the process of acetous fermentation in the spring and summer. And the propriety of such a system of procedure is evident when we reflect, that as in the autumn and winter, the atmosphere is charged with but a small amount of oxygen in the state of simple mixture, and in the spring and summer with a large amount; so the choice of the two periods for the respective purposes are judiciously made —in the first case to avoid the liability of an acetification of the wort previous to and during the vinous process of fermentation, and in the second case to facilitate the acetous process of fermentation, by the availment of the presence of an abundance of oxygen in the atmosphere. But admitting the superiority of the respective seasons for each purpose, yet we are of opinion that by the adoption of our expeditious system of brewing and refrigeration, accompanied by a suitable mode of fermentation, that the process of brewing and conducting the vinous fermentation, might be accomplished all the year through with perfect soundness and safety, and if so the question is, that if the work which is now required to be performed in six months was spread over the whole of the year, whether the magnitude of the premises and utensils might not be diminished to a moiety or less, causing the need of a smaller capital, less interest and current expenses of conducting business, and many other attendant advantages. The wort being properly prepared, by a vinous fermentation properly performed, to undergo the acetous process, the impartation of oxygen thereto by the agency of heat is effected. The supply of oxygen for the purpose is derived from the atmosphere, and the impartation must be slow and gradual, because a disarrangement and re-arrangement of the several classes of atoms composing the compound is required agreeable to their respective affinities, and the operation must be performed systematically and regularly in order to effect it advantageously. Such being the case, any attempt to accelerate the process with a greater rapidity than the disarrangement and re-arrangement of the several classes of atoms can be effected, is but to delay and defeat, instead of to promote and accomplish the operation successfully. Thus an attempt to facilitate and accelerate the acetification by an impartation of oxygen gas artificially manufactured, or by the impartation of artificial heat to an improper amount, will cause both loss and disappointment.

As the presence of spirit is necessary to enable the production of acetic acid, so is it necessary that its gradual conversion by atomic changes should be carefully performed, and as the evolation of alcohol at a very low temperature will occur, it is quite necessary that the impartation of heat to wort during the process of acetous fermentation, should be to the smallest amount sufficient for the purpose of its agency in the impartation of oxygen, and that it should be of a regular amount and continuous; and whether the supply of heat for the purpose is derived from the sun, or from the combustion of fuel, it is desirable and necessary that it should be both equable, continuous and of a moderate and suitable amount. It is also necessary that the supply of oxygen by medium of atmospheric air should be equable, continuous and of a suitable amount, and it may be desirable occasionally to impart to the atmosphere within the stove room a supply of oxygen gas, when the presence of an inadequate quantity naturally for the required purpose renders it necessary.

As the presence of a large amount of oxygen in a state of simple mixture within the stove room, is necessary to the accomplishment of the process of acetous fermentation, and as the generation of heat by the combustion of fuel, not only requires such oxygen and the constituent oxygen of the air to effect it, and as the presence of nitrogen gas is calculated to cause a putrefactive fermentation, so is it necessary that the combustion of the fuel should not be effected within the stove room, and that provision should be made for the exit of nitrogen gas, which may result from the decomposition of atmospheric air within the room, in the accomplishment of the process of acetification.

WATER, *one of the four elements.*

When chemical science was in a state of infancy, water was deemed a simple and indivisible element, and constituted one of the four simple elements into which it was imagined that all bodies and substances were resolvable, and which elements were denominated, earth, air, fire and water. But comparatively modern discoveries have proved, that pure water is divisible into two distinct gases, oxygen and hydrogen, and that such gases are composed of the ponderable atoms of oxygen and hydrogen, and the atoms of heat and light.

The atomic composition of water is said to be 15 parts by weight of hydrogen and 85 of oxygen; but we object to the statement, as well as to all the statements which are usually furnished of the atomic composition of various substances, on the ground that no mention is made of the proportions and amount of their constituent classes of imponderable atoms, such as heat and light. But acknowledging the utility of analysis and the statements as furnished, we are still of opinion, that we need a more correct system of analysis, and statements more accurately furnished, which will not only state the proportions and amount of the several gases by weight and volume into which those substances may be divided, but which will also furnish the proportions and amount of the several classes of ponderable and imponderable atoms into which those gases may be subdivided, and although convinced of the difficulties and impediments in the way of the accomplishment of such a purpose, yet we trust that they will ere long melt beneath some radiant master mind, and leave the basis of all scientific knowledge free and unincumbered with doubts, surmises, and hypotheses.

The universality of the presence of water within, upon and above the surface of the earth, is more than equal to the wants of the myriads of its inhabitants, for every diversified purpose for which it can possibly be needed, either as an atomic compound, or as relates to the classes of atoms in a state of division.

Water is diffused within, upon, and above the surface of the earth in a triple state—solid, in the form of ice, hail and snow; fluid, in the condition of water; and gaseous, in the state of vapour; and its conversion from and to either state, is due to the abstraction and impartation of heat.

The presence of water within the interior of the earth, is due to the law of gravity, which induces its descent from the surface toward the centre of the earth, and to the permeable condition of the strata through which it percolates. Its presence upon the surface of the earth is due to the law of gravity, which induces its descent from the atmosphere toward the centre of the earth, and to the impermeable condition of the strata or its covering through which it cannot penetrate, and to the state of solidity to which it is occasionally rendered, by the abstraction of a sufficient quantity of heat; and its presence in the atmosphere is due to the law of recession from the centre of the earth, or the law of gravity toward the centre of the sun to which heat is subject, which induces its recession in consequence of the impartation of a sufficient quantity of heat thereto, as to cause the balance of power between the gravity or tendency to fall toward the centre of the earth, to which the constituent ponderable atoms of vapour are subject, and the power of gravity or tendency to fall toward the centre of the sun to which the constituent imponderable atoms of vapour are subject, being in favor of the latter; or in other words, to the specific gravity of water being rendered less than that of the atmosphere, by the impartation of a sufficient quantity of heat thereto.

The circulation of water from the surface of the earth to the atmosphere, is due to the impartation of a large amount of heat thereto, which separates the constituent ponderable atoms of the water to such a distance from each other, as to render an equal bulk of the ponderable and imponderable atoms of which such water in such state is composed, to be of less statical weight than the ponderable and imponderable atoms of an equal bulk of atmospheric air, and consequently such water being of less specific gravity than the atmosphere, it ascends therein to such a height, as where both the gaseous fluids are of an equal weight. And the circulation of water from the atmosphere to the surface, is due to the abstraction of a large amount of heat from such vapour, which causes its constituent ponderable atoms to approach nearer to each other, in virtue of the law of attraction of aggregation to which they are subject, by which a bulk of such water is rendered of greater specific gravity than an equal bulk of atmospheric air, and consequently it descends to the surface of the earth induced by the law of gravity. The circulation of water from the surface to the interior of the earth is due to the law of gravity, and the circulation from the interior to the surface is due to the inequalities of such surface, and to the impermeable and permeable strata of the interior of the earth, enabling water to penetrate the elevated surface, and percolate into the interior, until it reaches an impermeable strata, and from thence to rise to a lower surface, impelled by the difference in the weight of the higher and the lower column. By this admirable system of arrangement, the sun shines upon the surface of water upon the earth, and imparting to it a sufficiency of heat converts it into vapour, which rises into the upper regions of the atmosphere, from which the heat imparted is soon abstracted by currents of cold air, and by such means the vapour is converted into dew, rain, snow or hail, (as may be the amount of heat abstracted) which is precipitated to the earth's surface, and such as falls on mountains, hills and elevated grounds, percolates into the interior of the earth until it arrives at some impermeable strata, over which it flows until some obstruction compels its falling or its upward course into the plain—a bubbling spring; and thus by this circulating round all nature is supplied with the refreshing stream.

The thermometric temperature of ice is 32 degrees, and it requires the impartation of 140 degrees of heat to convert it into fluid water of the thermometric temperature of 32 degrees, which may be ascertained by the insertion of a pound of ice in a pound of water, whose thermometric temperature is 172 degrees, when it will be found that the ice is melted and the thermometric temperature of the whole is 32 degrees; and by the exemplification of this fact, the caloric of fluidity of water is said to be 140 degrees. In this transaction, the free and active heat of the water, passes by transition into the interstices or areas presented by the arranged position of the ponderable atoms of the ice, as induced by the law of equal diffusion to which heat is subject; and as a pound of ice requires as much heat to fill those interstices or areas, and to separate the ponderable atoms from each other, as is sufficient to raise the temperature of a pound of water from 32 to 172 degrees of heat, so the 140 degrees which is thus imparted becomes the constituent heat of such ice converted into water, and therewith remains inactive and immoveable, until abstracted by some medium possessing a less amount of heat, and until then such heat is termed latent.

The thermometric temperature of water in a state of fluidity from the point at which it becomes solid to the point at which it is converted into vapour, ranges from 32 to about 212 degrees of heat, if such water is subject to the pressure of the atmosphere; but if not, the temperature at which it assumes the state of vapour is about 67 degrees.

Although water is convertible into vapour at a thermometric temperature of about 212 degrees subject to atmospheric pressure, yet a much larger amount of caloric is requisite to effect the purpose, and to an extent of from 900 to 1000 degrees; but the surplus amount imparted above 212 degrees becomes (what is termed) latent, forming the constituent amount which is necessary to place the ponderable atoms at a suitable distance, so as to render them and the constituent heat of less specific gravity than the atmosphere in which it floats.

The question may here be very properly asked, how do we account for the thermometer not indicating the whole amount of the heat which is required to convert water into vapour, and how do we reconcile the non-indication with the doctrine of the equal diffusion of heat which we have endeavoured to inculcate and establish. To which our reply is, that when a thermometer is suspended in aqueous vapour, the total amount of heat is not equally diffused among the ponderable atoms of which the vapour and the mercury are composed, for this reason, because the classes of ponderable atoms composing the mercury, are held in unison by a greater power of attraction of aggregation, than are the ponderable atoms of which the vapour is composed, which may arise from the influence of a stronger affinity subsisting between the classes of ponderable atoms of which the mercury is composed, and the classes of ponderable atoms of which the vapour is composed; and hence (without derogating from the doctrine of equal diffusion to which (we assume that) heat is subject,) we attribute the superior quantity of heat possessed by the vapour, to the difference in the amount of the resisting force presented to the diffusion by the ponderable atoms of each fluid. And as the expansion of the mercury is the measure of indication of the presence of heat in the vapour, its incapacity for the purpose lies in the inequality of the power of attraction of aggregation, which holds united the ponderable atoms of the respective bodies; and we therefore conceive that no instrument for the accurate admeasurement of heat in any given body can be formed, unless the indicative material of such instrument, is precisely the same in every respect as the body or substance to be examined, or whose ponderable atoms are held in unison by an equal amount of attractive power; and we are of opinion that were it possible to discover the means of forming an instrument that would correctly measure the amount of heat in every substance, that the term "latent heat" would soon be expunged from the scientific nomenclature.

Water raised from the surface of the earth by evaporation, is separated from its component substances, and in that state is a pure atomic compound of oxygen, hydrogen and caloric, in their standard proportions; and thus dew, mist, rain, snow and hail, furnish the purest water which is naturally obtainable, with the exception of such impurities as it may derive in its descent through the atmosphere, by admixture with a variety of substances, such as ovala of animalcules, seed, gaseous exhalations, soot, &c.

The water which descends from the atmosphere in the form of dew, mist, rain, hail or snow, is liable to and generally does dissolve a variety of substances in its passage, upon the surface or within the interior of the earth, which it holds in a state of chemical union, and many of which substances do not affect its color or transparency, but which affect its quality; and to separate it from such substances, either the process of distillation, chemical precipitation, or neutralization may be requisite.

With such water also a great variety of substances may be blended in a state of simple mixture, and the process of separation may be by depuration, precipitation or filtration.

The admixture of many substances with water in a state of chemical mixture, may either improve or deteriorate its qualities or properties as a beverage, or menstruum for the solution of a variety of substances; and the consumers of water as a solvent, which is prejudicially impregnated, may find it advantageous to avail themselves of some chemical agent to separate the deteriorating substance, or to cause the separation by distillation.

In the expeditious system of brewing which we recommend, and the details of which we have furnished in our Practical Treatise on Malting and Brewing, one portion of the process includes the distillation of water, and the supply of a very considerable amount of distilled water to be used as a mashing menstruum.

Water which is termed "hard," generally holds in chemical solution some acid; mineral, or metallic substance which it dissolves in its passage in the interior of the earth, or over its exterior surface; and such water proves much inferior as a menstruum for malted or unmalted grain, to that which is free from any impregnations, or which may hold in combination any substance that will facilitate solution.

The substance with which spring water is more commonly impregnated is chalk, which it will hold in solution to a small amount, and which it dissolves in its passage in the interior of the earth; and as there are two species of chalk, termed sulphate of lime and carbonate of lime, the former furnishing acid to water, and the latter carbon, so does the hardness or softness of water depend on its derivation during its passage over strata composed of either material.

The solution of saccharum and fecula is retarded, or in a measure prevented by the presence of acids in the menstruum, and to an extent proportionate to the amount of acid which it holds in solution; and the presence of such acid, with the addition of a superfluous quantity of oxygen to the wort, by impartation from the atmosphere, may cause it to experience a vino-acetous or an acetous fermentation.

The use of water which may hold in solution a variety of substances liable to putrefactive decomposition, either in a state of chemical combination or simple mixture, should be carefully avoided by brewers and others, who require a pure water for their various processes, unless it has been rendered previously pure by chemical remedies or mechanical separation.

One of the first and most prominent enquiries which should be made previous to the construction, purchase, or rental of a brewery or other factory requiring a pure menstruum, should be as to the quality and quantity of the supply of water, and if found to be of unsuitable quality, the next enquiry should be, what are the requisite means to improve it, and what the attendant cost and trouble.

YEAST, *an excretory product of beer in a state of vinous fermentation.*

The substance termed yeast furnishes us with another evidence among the many that we possess, of the bountiful provision of providence in furnishing the means to accomplish the production of every species of food which is necessary for the maintenance of life; and not only for the sustenance of the animal system, but also for the gratification of every passion with which his creatures are endued, restricting their beneficial influence to moderate consumption. Nor can we sufficiently admire the wisdom and beneficence of the great creator, who has withheld the various intoxicating beverages as natural productions, and has hedged around their artificial formation, with labour, cost and difficulties, as so many warning beacons against their immoderate use.

Every species of fruit, vegetable or grain which is able to furnish a fermentable extract, contains within itself its own fermentative material, and needs but the requisite manipulation, and the concurring circumstances to call its powers into action.

Thus fruit contains its own fermentative material in the husk, and the pressure which is necessary to extract the juice, breaks the vessels containing the ferment, and both are blended and extracted by the operation, and the mere exposure of the resulting product to the atmosphere, and the impartation of oxygen therefrom to the must, is sufficient to impel the fermentative material into action.

Grain contains its own fermentative material as a component of the substance within the interior of the husk, which material is denominated gluten, and which being dissolved in conjunction with the other soluble substances by a suitable menstruum, such as water, forms a compound fluid called wort by the brewer, and wash by the distiller, and needs but an exposure to the atmosphere to induce an acetous fermentation, as the natural result of the presence of such gluten, and the impartation of oxygen thereto.

But it is not the brewer's or distiller's purpose that a natural or artificial acetous fermentation should occur, nor even the vinegar manufacturer's in the first process, and therefore it is their business to prevent such an effect, by the insertion of good yeast into the wort or wash.

It then becomes necessary to enquire, what is the composition of yeast, which is able to avert an acetous fermentation and to cause the vinous? and the result of the enquiry is that it is a compound of coagulated gluten, and carbonic acid gas created by the process of vinous fermentation, evolved from the wort or wash which produces it, and the transfer of which to other wort or wash is necessary to insure a fulfilment of a similar operation.

It is usual for the brewer to boil his wort for the purpose of coagulating a portion of the gluten of the grain which has been dissolved by the menstruum, and to separate it from the other substances with which it is chemically combined by such coagulation, in order to avoid the liability of a vino-acetous fermentation which the presence of too much gluten in the fermenting tun might cause. But in carrying such a purpose into effect, it is necessary that he should exercise a sound discretion in apportioning the time of boiling, so as to cause the coagulation of as much gluten as is sufficient to prevent the liability of a vino-acetous fermentation, and yet leave enough uncoagulated behind, as may be necessary to ensure a proper vinous fermentation.

That the presence of a considerable quantity of gluten in wort is necessary to ensure a vinous fermentation, is evidenced by the result of the formation of a wort by the solution of sugar in water, and the addition of yeast thereto, when it will be found that for want of the presence of a sufficient quantity of gluten, an adequate vinous fermentation cannot be induced.

A wort possessing a sufficient quantity of gluten for the purpose of causing a proper vinous fermentation, needs the addition of yeast, not only to cause the commencement, but the continuation of the process.

Yeast.

It has been imagined by some, that the gluten forming part of the compound called yeast, is not necessary to cause the commencement or continuance of the vinous process of fermentation, and that its purport is merely to collect and to convey the carbonic acid gas to the wort to be fermented, and that the carbonic acid gas is the true cause of the commencement and continuance of the process of vinous fermentation; but such is not the case, as is verified in the attempt to cause the commencement and continuance by an impartation of carbonic acid gas alone to the wort, without the accomplishment of the purpose.

The impartation of coagulated gluten deprived by abstraction of its carbonic acid gas, will not cause a vinous fermentation, but on the contrary an acetous or a putrefactive fermentation.

The excretory products of vinous fermentation are coagulated gluten and carbonic acid gas; and as the gluten contained in unfermented wort is chemically combined with, and intimately diffused among the other substances, and the menstruum of which the wort is compounded; and as such wort contains no carbonic acid gas, it is necessary that a portion of such gluten should be coagulated and released from its state of chemical combination, and that carbonic acid gas should be created at the commencement and in continuation of the process; and the conditions which it appears it is necessary should be fulfilled to cause such commencement and continuation are, the impartation of coagulated gluten and carbonic acid gas enveloped in its vesicles, and oxygen from the atmosphere, with a reservation of a sufficient quantity of heat in the wort to facilitate the fermentative action of the fermentative materials.

The atomic composition of gluten, is oxygen 22, hydrogen 7.8, carbon 55.7, nitrogen 14.5 parts of 100, and it is the presence of nitrogen in yeast which renders it liable to putrefactive fermentation, and the large amount of carbon to acetous fermentation, while the presence of carbonic acid gas is its preservative principle; but as such gas is but evanescently retained, (the vesicles which contain it being liable to burst from several causes, such as expansion by heat, a fermentative action upon the wort which it holds in combination, &c.) so will a loss of the whole or a considerable portion of such gas, render yeast liable to experience an acetous or putrefactive fermentation; and therefore in storing yeast for the purpose of inducing fermentation, the greatest care is requisite to prevent the occurrence of such effects, and the exercise of care, discretion, and judgment in not making choice of yeast for the purpose which may have partially or totally experienced either.

FINIS.

Printed by R. Sickelmore, at 45, High Street, (late the Catholic Chapel) Brighton.